



216 PATERSON PLANK ROAD SITE  
CARLSTADT, NEW JERSEY

FOCUSED FEASIBILITY STUDY  
INVESTIGATION WORK PLAN  
FIRST OPERABLE UNIT FILL

*with ex-situ Treated Alternatives*

Prepared for:

The 216 Paterson Plank Road  
Cooperating PRP Group

Prepared by:



PROJECT No. 943-6222

APRIL 1996

*Revised  
5/97*

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July 31, 1997

Project No.: 943-6222

Chief, New Jersey Compliance Branch  
Emergency and Remedial Response Division  
U.S. Environmental Protection Agency, Region II  
290 Broadway  
New York, NY 10007-1866

Attn.: Mr. Jon Gorin, Remedial Project Manager

RE: 216 PATERSON PLANK ROAD, CARLSTADT, NJ  
FOCUSED FEASIBILITY STUDY INVESTIGATION WORK PLAN

Gentlemen:

Following your letter dated June 20, 1997 approving the redline revised version of the above Work Plan, and on behalf of the 216 Paterson Plank Road Cooperating PRP Group, we enclose four copies of the final version of the text of the Work Plan, the associated Sampling, Analysis & Monitoring Plan and Quality Assurance Plan, and a new cover indicating the date of the final version (May 1997). Please replace these sections and the cover of your copies of the original Work Plan (dated April 1996) with the enclosed copies. Copies of each document have also been provided to the New Jersey Department of Environmental Protection under separate cover.

If you have any questions related to this matter, please do not hesitate to contact me.

Very truly yours,

GOLDER ASSOCIATES INC.

P. Stephen Finn, C.Eng.  
Facility Coordinator

cc: Chief, Bureau of Federal Case Management  
N.J. Department of Environmental Protection  
Attn: Riché Outlaw, Case Manager

Warren L. Warren, Esq., Drinker, Biddle & Reath  
Technical Committee Implementation Group

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April 3, 1996

Project No.: 943-6222

Chief, New Jersey Compliance Branch  
Emergency and Remedial Response Division  
U.S. Environmental Protection Agency, Region II  
290 Broadway  
New York, NY 10007-1866

Attn.: Mr. Richard Puvogel, Remedial Project Manager

RE: 216 PATERSON PLANK ROAD, CARLSTADT, NJ  
FOCUSED FEASIBILITY STUDY INVESTIGATION WORK PLAN

Gentlemen:

On behalf of the 216 Paterson Plank Road Cooperating PRP Group, we enclose four copies of the above Work Plan which has been prepared pursuant to our meeting on January 25, 1996 and subsequent telephone discussions. Four copies have also been provided to the New Jersey Department of Environmental Protection under separate cover.

The enclosed Work Plan serves several purposes;

- The existing data on the physical characteristics of the First Operable Unit (FOU) soils are presented and discussed.
- The technical implementation challenges to be faced during site-wide excavation are presented and discussed. As you are aware, this analysis lead us to conclude that remedial alternatives that involve side wide excavation should be eliminated.
- Appendix B contains the preliminary geotechnical analysis of excavation side slope stability, which was specifically requested by EPA.
- The basis for interpreting the likely presence of a "hot spot" in the eastern portion of the site is presented.
- A field program to determine the location, nature, and extent of the "hot spot" is described, and detailed field procedures and quality assurance provisions are presented in appendices.
- An updated schedule is provided, exercising the contingency which was built into the approved FFS Work Plan schedule, and allowing for Agency review and approval of the enclosed Investigation Work Plan.

We trust that the enclosed Work Plan is fully responsive to the issues raised by our January 25 meeting, and we look forward to receiving early approval so that we may proceed with the field work.

YES HOT  
SPOT FOU  
OK 8/5

101005

U.S. Environmental Protection Agency  
Mr. Richard Puvogel

-2-

April 3, 1996  
943-6222

If any questions arise during your review of the enclosed Work Plan, please do not hesitate to contact me.

Very truly yours,

GOLDER ASSOCIATES INC.



P. Stephen Finn, C.Eng.  
Facility Coordinator

cc: Chief, Bureau of Federal Case Management  
N.J. Department of Environmental Protection  
Attn: Riché Outlaw, Case Manager

Warren L. Warren, Esq., CSPA&C

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**216 PATERSON PLANK ROAD SITE  
CARLSTADT, NEW JERSEY**

**FOCUSED FEASIBILITY STUDY INVESTIGATION  
WORK PLAN**

Prepared for:

The 216 Paterson Plank Road Cooperating PRP Group

Prepared by:

Golder Associates Inc.  
305 Fellowship Road, Suite 200  
Mt. Laurel, New Jersey

**DISTRIBUTION:**

- 4 Copies - U.S. Environmental Protection Agency
- 3 Copies - NJ Department of Environmental Protection
- 1 Copy - Cooperating PRP Group Technical Committee Implementation Group Members
- 1 Copy - Common Counsel
- 2 Copies - Golder Associates Inc.

May 1997

Project No.: 943-6222

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## 1.0 INTRODUCTION

On behalf of the 216 Paterson Plank Road Cooperating PRP Group (Group), Golder Associates Inc. (Golder Associates) submits this Focused Feasibility Study Investigation Work Plan (FFSI Work Plan) for the collection of additional data needed to complete the Focused Feasibility Study (FFS) for the First Operable Unit (FOU) fill at the 216 Paterson Plank Road Site (Site) in Carlstadt, New Jersey.

The 6-acre site is a former chemical recycling and waste processing facility which ceased operation in 1980 and was placed on USEPA's National Priorities List (NPL) in 1983. A remedial investigation was initiated in 1987 leading to a USEPA Record of Decision (ROD) in 1990. Interim Remedial Measures, pursuant to the ROD, have been in place at the Site since 1992 and include a slurry wall containment system which encompasses the FOU fill zone. The present FFS is being conducted at the request of USEPA to provide a basis for selection of a final remedy for the FOU. The work is being conducted in accordance with an approved Work Plan (Golder Associates, 1995) which also addresses investigation of the deeper groundwater in the vicinity of the Site.

In accordance with the Work Plan, Golder Associates has completed Phase I of the FFS, Development of Remedial Alternatives. On January 25, 1996, Group representatives and Golder Associates met with USEPA and presented the Phase I results that included a summary of existing data, recommended remedial alternatives for consideration in Phase II of the FFS (Detailed Evaluation of Alternatives), and data gaps required to be filled to complete the detailed evaluation.

This FFSI Work Plan presents the major data gaps identified that include a need to more conclusively define a potential "hot-spot" area, and verify the geotechnical properties of the soils directly underlying the FOU. At this time, further treatability studies are not planned but the need for such studies may be reconsidered based on the results of the investigation described herein. In particular, the data obtained will be compiled and evaluated with a view to possible future treatability study/pilot work on in-situ remedial technologies. In addition, Phase I of the FFS identified a number of severe limitations and complex issues associated with remedial options that encompass excavation, material handling, and treatment as a result of the large amount of construction and demolition (C&D) debris contained within the FOU fill. This FFSI Work Plan also discusses the limitations associated with ex-situ treatment alternatives for the FOU.

The USEPA has requested that the Group complete this work plan for an investigation to address the data gaps presented at the January 25, 1996 meeting. This FFSI Work Plan provides the framework for the FFS Investigation, and describes the objectives, methodologies, schedule and organization. Administratively, the work is being conducted pursuant to the additional work provisions of an Administrative Order on Consent (Index No. CERCLA II-50114) dated September 30, 1985 (RI/FS Order).

### **1.1 Project Objectives**

The FFSI work has a single primary objective: to gather data necessary to complete the evaluation of remedial alternatives for a sludge "hot-spot" area. This, in turn, entails determining the nature and extent of the sludge and its chemical characteristics, together with the geotechnical properties of the natural materials underlying the "hot-spot". As further discussed in Section 4, these geotechnical properties are significant to a technical evaluation of the feasibility of potential "hot-spot" excavation remedial alternatives. The project objective will be accomplished using a combination of geophysical survey techniques and a biased soil boring and sampling program. The geophysical survey will be used to define the approximate location and boundary of the potential sludge "hot-spot" area and to focus the subsequent soil boring program. The soil boring program will be used to define the nature and extent of the sludge "hot-spot" area. Samples will be collected during the boring program which will be submitted to separate laboratories for chemical and geotechnical analyses.

Based on the RI data, the primary chemicals of concern are volatile organic compounds (VOCs) and polychlorinated biphenyls (PCBs). However, since the data obtained in this investigation is to be used for remedy selection purposes, and potentially for risk assessment, chemical analyses will include all Target Compound List (TCL) Organic Constituents, and the Target Analyte List (TAL) metals, as defined in the USEPA Contract Laboratory Program (CLP) Statement of Work (SOWs). Final cleanup levels have not been established for the Site, but the CLP contract required quantitation limits are several orders of magnitude lower than the Preliminary Remediation Goals established by USEPA (see Section 2). In view of the potential use of the data for risk assessment, Data Quality Objective (DQO) Level IV has been selected for the TCL/TAL analysis and the data will be validated in accordance with the QAPP and USEPA Region II guidance. Samples will also be analyzed by the chemical laboratory for the secondary parameters of oil and grease and total organic carbon, for which DQO Level III is considered appropriate. The geotechnical testing data

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will be used solely for preliminary evaluation of potential excavation feasibility and, in accordance with USEPA's DQO Guidance Scheme, these data are not assigned a numeric DQO classification.

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## 2.0 SITE BACKGROUND

The six-acre Site is a former chemical recycling and waste processing facility which ceased operation in 1980 and is located in a light industrial/commercial area of Carlstadt, New Jersey (Figure 1). The property is bordered to the southwest by Paterson Plank Road, to the northwest by Gotham Parkway, to the southeast by a trucking company, and to the northeast by Peach Island Creek. The Site was placed on USEPA's National Priorities List (NPL) in 1983.

The following sections provide a brief overview of the pertinent results and conclusions of investigations conducted within the FOU fill at the Site to date.

### 2.1 Summary of FOU Fill Material Characteristics

Test pit and boring investigations conducted within the FOU fill during the Remedial Investigation (1986-1989) have provided valuable information which defines the physical characteristics of the FOU fill. Twenty-three test pits and thirty-one borings were completed and the approximate locations are presented on Figure 2. In addition, eighteen soil borings (Canonie, 1991) were installed around the perimeter of the Site as part of the slurry wall design investigation (see Figure 2). Based on the current data, the following conclusions can be drawn.

1. The FOU fill material consists of a variety of construction and demolition (C&D) debris including large blocks of reinforced concrete and rock, steel beams, timber, stumps, scrap metal, fencing, piping, cable, brick, ceramic, concrete masonry block, rock/concrete rubble, etc. (Dames and Moore, 1990). Finer grained materials such as sands, gravels, silts, clays, and sludge-like material were identified mixed within the C&D debris. There does not appear to be any pattern of debris disposal at the Site except that smaller amounts of debris were detected in the eastern portion in the vicinity of boring B-1. C&D debris was present in every test pit except for one which was terminated at a shallow depth (approximately 2 feet) due to high VOC levels. Copies of photographs of the C&D debris identified at the Site during the Interim Remedial Measures (IRM) construction are provided in Appendix A.
2. Previous estimates have indicated that between 50 and 80 percent of the FOU fill consists of C&D debris (ERM, 1989). Golder Associates has carefully reviewed the Test Pit Study Report (Dames and Moore, 1989) and photographs of subsurface material and has revised the previous estimates to about 60% (i.e., approximately 60% of the FOU material is C&D debris and the remaining approximately 40% consists of finer grained particles within the C&D debris). Figure 3 graphically depicts the percentage of C&D debris and the estimated particle size breakdown within the C&D debris fraction. The C&D debris fraction ranges in size up to pieces greater than several feet. As shown on Figure 3, a large portion of the C&D debris fraction is estimated to be greater than 6 inches in size.

3. During the construction of the slurry wall, excavated debris was disposed into a slurry hydration pond built on-Site (see Photograph No. 1, Appendix A). In addition, the above ground debris piles and building remnants (e.g., see Photograph Nos. 5, 6, 7, 8, Appendix A) were graded beneath the IRM cover. Both of these activities are expected to have increased the already high proportion of C&D debris identified during the RI studies.
4. The standard penetration test data (blow counts) recorded from the Remedial Investigation boring program indicate that the large majority of blow counts are greater than 50 per foot (see Figure 4). Many are reported greater than 100 per foot and as high as 200 per foot. It is worth noting that the blow counts for a compact coarse grained soil typically range from 10 to 30 per foot. These data again suggest that much of the material encountered in the borings consists of debris and there does not appear to be any particular pattern of placement. The lowest blow counts were measured at boring locations MW-7D and B-1 which were generally less than 10 per foot. At location B-1 penetration of the sludge-like material encountered occurred under the self-weight of the equipment (zero blow counts).
5. The blow counts recorded from the RI and slurry wall construction boring programs and information from the test pit logs (e.g. size and percentage of debris) for the 0 to 6 foot depth interval have been incorporated into a geographical information system (GIS) database to provide a graphical interpretation of the subsurface physical characteristics. Figure 5 shows areas of the Site where C&D debris were identified based on information from both the test pit and boring logs and areas where C&D debris were not identified. For this figure, locations having blow counts greater than 30 per foot were considered to contain C&D debris. As shown on Figure 5, C&D debris covers approximately 87% of the Site.

Figure 6 is based on the test pit study results only and shows areas of the Site having C&D debris greater than 6 inches, C&D debris less than 6 inches, and finer grained particle size material. As shown on Figure 6, larger size C&D debris is expected to be distributed over approximately 52% of the Site and smaller size C&D debris is shown to cover approximately 44% of the Site. The approximate location of the slurry hydration pond, which was filled with large excavated C&D debris during the IRM construction, is shown on both Figures 5 and 6.

6. In both the test pit study and boring program, elevated levels of VOCs were noted. Level B personal protective equipment was required during all test pit excavations. Eleven of the twenty-three test pits were terminated due to high VOC levels. Respiratory protection was frequently required during the drilling program. Photoionization detector readings of VOCs were recorded at or above 100 ppm in all but two borings and as high as 1000 (+) ppm in several of the borings. High VOC levels also became problematic during the construction of the slurry wall and required portions of the slurry wall excavation to be performed in Level B with attendant inefficiency. The use of foams on stockpiles to reduce VOC impacts to nearby receptors and workers was also required during the slurry wall construction (e.g., see Photograph No. 9, Appendix A).
7. A review of historical aerial photographs indicates that between the late 1960s and 1980, two ponds existed at the eastern corner of the Site in the vicinity of borings B-1 and MW-7D. As noted above, borings B-1 and MW-7D exhibited some of the lowest blow counts



recorded at the Site. The approximate boundaries of the original ponds, based on the aerial photographs, are shown on Figure 2.

8. A "meadow mat" layer lies at the base of the FOU and consists of a highly organic silt and clay material. This meadow mat layer is interpreted to have a low shear strength based upon the very low blow counts recorded for the unit which are generally on the order of 2 per foot. Directly underlying the meadow mat layer are layers of silts and clays which are also low strength materials.

## **2.2 Potential "Hot-Spot" Analysis**

### **2.2.1 Summary of Analytical Results**

During the remedial investigation, 34 soil samples were collected within the FOU fill from 17 boring locations (Dames and Moore, 1990). Boring locations were biased toward potential source areas as identified in aerial photographs and former operation areas. Samples were collected from each boring at two intervals: 0 to 2 feet (surface) and 5 to 6 feet (subsurface). The samples were analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, PCBs, and metals.

A number of chemical constituents were detected, primarily VOCs, SVOCs (generally polynuclear aromatic hydrocarbons or PAHs), a small number of pesticides, PCBs, and metals. While the maximum detected concentration of some of these constituents is elevated (e.g., 15,000 mg/kg PCB at the surface interval in boring B-1), most constituent detections are less than the USEPA preliminary remediation goals (PRGs; USEPA letter dated November 19, 1993). Table 1 provides a summary of the number of constituent concentrations which were detected above the USEPA PRG. It should be noted that the PRGs are not final cleanup goals. The selected remedy and cleanup goals will be included in a subsequent ROD

With respect to the PCB results, only two other boring locations besides B-1 exhibited PCB concentrations in excess of 100 mg/kg (boring MW-3S, two detections up to 290 mg/kg, and boring MW-2D, one detection at 350 mg/kg). All other PCB detections (30 of 34 samples) were less than 100 mg/kg i.e., at least two orders of magnitude less than the PCB concentration detected at B-1. Boring B-1 also exhibited the highest levels of VOCs as well as elevated concentrations of copper and lead.

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### 2.2.2 Identification of Potential "Hot-Spot"

For present purposes, a "hot-spot" is considered to be:

- an area where, if the chemical constituents are removed and/or treated, the site-wide risk would be reduced by over an order of magnitude; and,
- an area small enough to be considered separately from remediation of the entire FOU.

It is important to note that the PCB concentration detected in boring B-1 (15,000 mg/kg) accounts for about 97% of the total estimated carcinogenic risk at the Site for both current and potential future surface soil exposures (Clement Associates, Inc., 1990). Clearly, PCBs at boring location B-1 are driving the potential Site risks. It is important to note that the estimated risk is presently being mitigated by the interim remedy cover installed at the Site.

Using the same exposure assumptions, toxicity factors, and risk estimate equations presented in the Baseline Risk Assessment (BRA) conducted by Clement Associates Inc. (March 1990) for USEPA, Site-wide risk estimates have been calculated for different potential hot-spot remediation scenarios as shown in Table 2. The results of the "hot-spot" analyses (Table 2) demonstrate that the area at boring location B-1 fits the working definition of a "hot-spot" presented above; the remediation of PCBs from the B-1 "hot-spot" area would yield almost a two order of magnitude reduction of risk. The three other potential "hot-spot" scenarios evaluated do not yield any appreciable additional risk reduction as compared to the B-1 scenario.

Therefore, considering the potential risk reduction, the lesser amounts of debris encountered at B-1, and its location in the vicinity of the two former ponds, the area surrounding B-1 is considered to be a potential "hot-spot" at the Site.

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### **3.0 TECHNICAL EVALUATION OF EX-SITU TREATMENT ALTERNATIVES**

Excavation and material handling would need to be completed prior to the application of any of the ex-situ treatment alternatives considered in the FFS (i.e., stabilization/solidification, thermal desorption, biological degradation). The difficulties and risks associated with FOU fill excavation and handling at the Site are sufficiently severe and limiting that remedial alternatives requiring extensive excavation/handling prior to ex-situ treatment should be eliminated from further consideration in the FFS. These challenges, limitations, and risks are discussed below.

#### **3.1 FOU Fill Excavation**

##### **3.1.1 Excavation Process**

1. Due to the heterogeneous nature and large size of debris, significant manual work would be required to direct the operation of heavy equipment and to manually separate materials during excavation. Concerns for worker safety would be elevated and production rates slowed.
2. Numerous excavated material stockpiles would have to be created for the various material types, sizes, conditions, and chemical characteristics as they are separated. Separate stockpiles are envisioned for the following categories of material: large size debris suitable for size reduction; large size debris unsuitable for size reduction; saturated fill; unsaturated fill; rubber and plastics; metal (cable, wire, pipe, etc.) and predominantly small grain size fill. Certain debris may be further divided into individual stockpiles (e.g., reinforced concrete, large timber, tires, etc.).
3. Due to the variety of debris that will be encountered, several types of heavy equipment would be needed for excavation, including backhoes, cranes, dump trucks, flat beds, support vehicles, etc. Staging, decontamination, and refueling stations would be required.
4. Extensive dewatering would need to be conducted prior to or during any excavation activities. Notwithstanding the dewatering efforts which form part of the Interim Remedy, it is expected that near saturated conditions will remain and pockets of saturated material would be present. In addition, based on observations in wells and piezometers, non-aqueous phase liquid (NAPL) is also expected to be encountered. Water and NAPL will need to be removed from excavations, separated, stored, treated, and/or disposed of off-site. Saturated excavated materials will need to be drained of free liquid and NAPL prior to further material separation/stockpiling/handling; a process which may take days to weeks. These conditions are expected to slow and complicate the excavation process, and present additional safety hazards for workers.
5. Numerous physical hazards to workers would exist because of the handling of the heterogeneous/large size debris, slippery conditions (saturated fill and NAPL), and working in cumbersome Level B personnel protection. The net effect of these conditions

would be to slow excavation progress and put workers and off-Site receptors at an elevated health and safety risk.

6. Very limited space is available to conduct the required activities further complicating the process.
7. Extensive decontamination (both personnel and equipment) would be required to minimize the spread of contaminants on-site and off-site. Implementing these activities will further complicate and slow the excavation and material handling progress.
8. Control of VOC vapors, dust, and odors and extensive air monitoring would need to be provided to protect the health and safety of both workers and nearby receptors.
9. Control of precipitation run-on into excavation/material handling areas and precipitation run-off from these areas would need to be provided to protect both nearby human and ecological receptors.

### **3.1.2 Preliminary Excavation Stability Analysis**

The soft soils (meadow mat, silts and clays) immediately underlying the FOU fill are cause for further concern with respect to FOU fill excavation. As discussed in Section 2.1, the meadow mat layer (soft silt and clays, high in organic content) is interpreted to have a low shear strength based on the low recorded blow counts (on the order of 2).

In order to protect the integrity of the existing slurry wall, a stable excavation side slope angle will need to be maintained. The slurry wall is a non-structural feature and failure of the excavation side slope would cause a corresponding failure of the adjacent section of the slurry wall. Preservation of the slurry wall is an essential component of any remedial action since, as USEPA noted its 1990 Record of Decision for the Site, "The elements of the interim remedy are prerequisite components of a permanent remedial action for the first operation unit zone."

A preliminary excavation stability analysis has been conducted for three different side slopes angles (see Appendix B). The analysis shows that an excavation side slope angle of three horizontal to one vertical (3H:1V) would be only marginally stable and a slope of 4H:1V would be required for stability even under temporary, short-term construction conditions. Considering a 4H:1V side slope angle, an average 10 foot thickness of fill and meadow mat, and a 5-foot buffer zone to protect the slurry wall, approximately 16,000 cubic yards, or about 18% of the FOU fill within the slurry wall would have to be left in place to protect the slurry wall (see Appendix B, Figure B2).

Because of the large volume of FOU fill which could not be excavated, the use of a sheet pile wall to support the excavation was considered as a means to increase the potential excavation volume. However, a sheet pile wall cannot be successfully used to stabilize the slurry wall during FOU fill excavation for the following reasons:

1. Due to the amount and large nature of debris, a sheet pile wall could not be installed through the debris without excavation (as was necessary to install the existing sheet pile wall along Peach Island Creek which was constructed prior to the slurry wall). Excavation of debris adjacent to the slurry wall could cause failure of the surrounding soil and damage to the wall.
2. Low-strength clay soils (glaciolacustrine varved unit) underlie the meadow mat layer. To provide adequate strength for the wall, the sheet piles would likely need to be driven through the low permeability confining unit and into the underlying till. However, penetrating the clay confining unit could create a downward migration pathway for constituents (including NAPLs) contained within the FOU fill, (i.e., the existing containment system would be compromised and additional spread of contamination could result). Such migration could be exacerbated by the downward hydraulic gradients which exist between the FOU fill water and the underlying groundwater unit.

In light of the geotechnical limitations, a significant volume of FOU fill could not be removed and treated without jeopardizing the integrity of the existing containment system. These limitations severely decrease the effectiveness of ex-situ remediation alternatives being considered in the FFS.

### **3.2 Material Handling**

1. Multiple screening steps would be required to provide adequate separation of FOU fill debris and would include, at a minimum, manual separation, magnetic separation, and various types of screening (e.g., vibratory and inclined).
2. Several additional stockpiles, including material loading and unloading areas, would be required to be maintained prior to and after most of the material handling steps.
3. Size reduction (crushing, shredding, and manual cutting) and further material separation, screening, and stockpiling would be required for a large portion of the debris.
4. Significant worker safety issues (physical and chemical hazards), air monitoring, decontamination, control of VOC, dust and odors, and protection of nearby receptors during material handling activities will be a concern.
5. Preconditioning for thermal desorption would include requiring saturated stockpiles of fill to grain and dry to a moisture content of less than 40% prior to treatment.
6. Preconditioning for biological treatment would require up to 50% amendment addition (resulting in volume increase of the waste) and homogenization of various fill types.

7. Treatment preconditioning will require the use and maintenance of additional stockpiles for materials in different stages of preconditioning.

### **3.3 VOC/Dust/Odor Controls**

#### **3.3.1 Enclosures**

Previous consultants (ERM, 1989) concluded that over 99.9% of the VOC and dust emissions from the Site would need to be controlled to protect a worst-case nearby off-site receptor. This control requirement is based on the approximate emissions generated as a result of only limited excavation/material handling activities (one backhoe, one truck, and loading/unloading). Most of the dynamic material handling steps that would be required, as described above, were not considered. In addition to the human health risks associated with VOC and dust emissions from the Site during excavation and material handling, nuisance odors are also likely to be a concern since the Site is located in a developed area. Therefore, because of the additional material handling requirements which would result in increased emissions and a corresponding increase in the degree of controls required, it is probable that the excavation and material handling activities for the entire Site would need to be conducted within an enclosed structure and emissions from the enclosure would require treatment prior to being discharged to the atmosphere. The additional difficulties associated with conducting the excavation and material handling activities within an enclosure are numerous as described below.

1. Large and likely multiple enclosures would be required to contain emissions from the numerous excavation and material handling steps; construction and maintenance of such enclosures on such a confined site would be extremely complex.
2. The rate of ventilation (and corresponding treatment) would need to be properly sized to prevent buildup of VOC vapors, and prevent buildup of explosive gas mixtures. USEPA has shown that the required ventilation rates can be higher than expected to provide the necessary level of protection (USEPA, 1992).
3. Additional VOC, carbon monoxide, and particulates would be emitted by heavy equipment (diesel/gas engine exhaust) operating within the enclosure which would exacerbate health and safety risks.
4. The risks associated with damage, leakage or rupture of the enclosure and decreased efficiency or failure of emission control equipment leading to releases of VOC and odors to the atmosphere are significant.

5. Health and safety considerations for workers within enclosures include the following:

- USEPA has documented that there is generally a 20°F increase in temperature within an enclosure compared to outdoor ambient temperatures (USEPA, 1992). The higher temperatures are cause for concern in terms of elevated VOC emissions, humidity and heat exhaustion for workers, especially when using Level B PPE.
  - Physical hazards associated with material handling, separation and other manual activities conducted by workers within an enclosure are a particular concern as a result of reduced visibility (level B protection, reduced light, and smoke from heavy equipment exhaust), slippery conditions, reduced worker mobility in Level B, heat stress, and expected congested conditions within the enclosure.
6. High humidity may cause reduced emission control effectiveness if vapor phase GAC is used for treatment of ventilation air.
7. There would be limited available space within the enclosure(s) to perform the necessary excavation and material handling activities causing congested work conditions and reduced efficiency.

### 3.3.2 Pretreatment Using Soil Vapor Extraction

One possible method to reduce potential VOC emissions from excavation and material handling activities would be to employ in-situ soil vapor extraction (SVE) prior to excavation of the FOU fill. This approach would reduce the VOC content of the FOU fill and theoretically the need to control VOC emissions. Realistically however, while SVE is expected to be successful in removing a portion of the VOCs from the FOU fill, there are a number of site specific constraints which would limit its effectiveness to below that likely to be required to preclude the need for VOC emission controls during excavation.

As discussed previously, a screening level risk assessment was performed as part of the 1989 Feasibility Study (ERM, 1989) which estimated that the total excess carcinogenic risk to an individual outside the Site property line during uncontrolled excavation activities would be approximately  $8.5 \times 10^{-3}$ . About one half of the risk estimate was attributable to VOC vapors and the other half to PCBs in dust. This risk screening only considered emissions from the operation of one backhoe and one truck. Emissions from the other material handling activities discussed above were not taken into account and will result in higher emission rates.

Based on the risk screening results, approximately 99% of the VOC emissions would need to be controlled or pretreated by SVE to reduce the risk to  $4 \times 10^{-5}$  and over 99.9% control would be required to reduce the estimated cancer risk to less than  $1 \times 10^{-6}$ . Therefore, it is unlikely that SVE will provide a high enough level of VOC reduction to appropriately mitigate the risk during excavation and material handling nor will it mitigate dust emissions.

Foster Wheeler Enviresponse, Inc. conducted a site-specific SVE treatability study for USEPA Region II (Foster Wheeler Enviresponse, Inc., 1992) that concluded ... "Based upon the treatability test data, the effectiveness of SVE at Carlstadt is highly questionable. The high residual saturation of moisture in the soil matrix, the low permeability of the soil matrix, the probable presence of non aqueous phase liquids (NAPLs) and the heterogeneity of the fill material are strong indications that SVE will be difficult to implement effectively at the SCP site."

While SVE would remove a portion of the subsurface VOC and odors, because of the high degree of performance required to reduce potential VOC emissions by over 99.9%, it is anticipated that VOC and odor controls, such as the use of enclosures, would likely still be required during excavation and material handling even after SVE is implemented.

### **3.3.3 Other Methods for Controlling VOCs, Odors and Dust**

There are a number of other engineering controls which can be used to suppress VOC, dust and odors during conventional excavation and material handling. These controls include the following:

- Dust suppression by water sprays;
- VOC/dust/odor suppression by foam and sprayed-on temporary membranes;
- Temporary geosynthetic covers; and,
- Reducing the rate of excavation.

Reducing the rate of excavation to provide over a 99% reduction of VOC is not considered feasible due to the extended duration of the excavation process (over 100 times longer).

The activities which present the most difficulties with respect to VOC/dust/odor controls have been termed by USEPA as dynamic activities (USEPA, 1992). These activities have the



characteristics of continuous exposed contaminated surfaces as a result of machinery operation and nearly continuous material movement. Dynamic activities would include:

- Excavation;
- Loading/unloading;
- Separation/screening;
- Size reduction;
- Preconditioning (such as homogenization and/or amendment addition); and
- Treatment/decontamination of debris.

USEPA concluded (USEPA, 1992) that the use of foams is not an effective method for controlling VOC emissions from dynamic material handling processes. In fact, this study demonstrated that the use of foams may even hamper excavation/material handling activities by causing slippery conditions for both machinery and workers, increasing the concern for worker health and safety and reducing productivity (see Photograph 9, Appendix A). Water sprays, sprayed on temporary membranes and temporary covers are also not expected to be effective for controlling VOC/odor emissions from the dynamic material handling activities. Water and foam sprays would have a higher degree of effectiveness for controlling dust during the dynamic material handling activities as a result of maintaining a higher moisture content.

The use of the engineering controls for the suppression of VOC/dust/odors from the static excavation/material handling activities is considered to be effective. The static activities are considered activities where the material would be motionless for extended periods of time, such as:

- Excavation pits/side slopes not being used;
- Roads; and
- Stockpiles (where no loading/unloading is occurring).

The use of foam, sprayed on temporary membranes, temporary covers and water sprays (for dust) are considered to be effective for controlling potential VOC/dust/odors emissions from static activities.

### **3.4 Waste Stream Management**

Numerous waste streams would be generated as a result of conducting the excavation and material handling activities. The management of these waste streams would add to the already

complex nature of the excavation and material handling processes and would consume considerable physical space in the already limited area. Some of the waste streams which would be generated are listed below.

**Aqueous Liquids:**

- water from extraction/dewatering/excavations
- drainage from saturated fill
- precipitation runoff from impacted areas
- wash water from decontamination of equipment and workers
- water from treatment (washing) of debris
- scrubber water from air pollution control equipment (if used)

**NAPL:**

- phase separation from fill water
- direct pumping of NAPL from excavation
- phase separation from treatment of debris
- use, storage and disposal of saturated absorbents

**Air Emissions:**

- fugitive emissions from excavation/fill handling
- emissions from enclosures
- air emissions for debris treatment prior to off-site disposal
- possible emission from on-Site waste water treatment

**Debris:**

- treatment of debris prior to off-site disposal
- washing for disposal as non-hazardous waste
- macroencapsulation and microencapsulation for disposal as hazardous waste
- multiple piles

### **3.5 Available Space Restriction**

Due to the complexity and number of the excavation, material handling, and waste handling activities being conducted and the small area of the Site, severe spacial limitations are anticipated. The major activities which pose the highest space requirements include:

- excavation and material handling enclosures;
- material stockpiles;
- equipment staging/refueling areas;
- personnel and equipment decontamination areas;
- clean zones for equipment storage and personnel;
- open excavation for replacement of material;
- liquid storage and/or treatment tanks and loading/unloading areas;
- liquid conveyance piping and pumps;
- stormwater collection/diversion structures;

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- air emissions control equipment and support facilities;
  - debris treatment/decontamination areas;
  - off-site material transportation storage areas; and
  - administrative offices, etc.

In addition to the large amount of space required just for the fill excavation and material handling process described above, additional space would be required for any ex-situ treatment process and support facilities.

### 3.6 Summary

Extensive excavation and material handling prior to ex-situ treatment at the Site is not considered a viable process. As a result of the physical and chemical characteristics of the FOU fill at the Site, there are numerous processes which would need to be conducted almost simultaneously. Implementing these processes is expected to be extremely difficult and for all practical purposes impossible given their overall complexity and the limited space available. Most importantly, however, are the elevated health and safety risks to construction workers and potential impacts to off-Site receptors which would result when attempting to implement the excavation and material handling processes. Serious concerns for worker health and safety exist as a result of potentially having to work in enclosures, in Level B protective equipment, operating heavy equipment and performing manual work in crowded, slippery, and reduced visibility conditions. In addition, nearby receptors would be at significant risk. These issues raise serious short-term effectiveness concerns with all alternatives which involve excavation and material handling.

Furthermore, approximately 18% of the FOU fill could not be excavated for geotechnical reasons. Having to leave almost one-fifth of the FOU fill in place severely limits the long-term effectiveness of ex-situ treatment alternatives. Overall, due to the extremely difficult implementability, serious short-term effectiveness concerns and limited long term effectiveness, it is recommended that ex-situ treatment alternatives be eliminated from further consideration in the FFS, with the exception of potential "hot-spot" removal. Ex-situ alternatives for the potential "hot-spot" area which can achieve substantial risk reduction will be evaluated based on the data collected as part of this FFSI.

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## **4.0 DATA GAPS AND TECHNICAL APPROACH**

Based on the discussions presented in Sections 2.0 and 3.0, the data gaps required to be filled to complete Phase II of the FFS are the delineation of the identified potential "hot-spot" area in the vicinity of boring B-1 and further evaluation of the geotechnical properties of the meadow mat below the potential "hot-spot" area. Further evaluation of the physical characteristics of the remainder of the FOU fill is not required because remedial alternatives which include excavation and material handling of the FOU fill are recommended for elimination. The remainder of this FFS Investigation Work Plan focuses on presenting procedures to define the characteristics of the potential "hot-spot" area.

### **4.1 Characterization of "Hot-Spot"**

#### **4.1.1 Identification of Data Gap**

The analysis presented in Section 2.2, identified boring location area B-1 (east corner of the Site) as a potential "hot-spot." Boring location B-1 is believed to represent an area in which focused remediation will be effective in significantly reducing the overall future Site risk. The materials encountered in the B-1 area have been described as "sludge," with little penetration resistance and no debris. Also, as previously stated, PCBs were detected at location B-1 at concentrations two orders of magnitude higher than any other location at the Site and the area corresponds to two former ponds shown in historic aerial photographs and referred to as possible "sludge disposal" areas in the RI (Dames and Moore, 1990).

A review of the 1968 and 1970 aerial photographs show the two ponds present in the eastern area of the Site. 1976 and 1978 aerial photographs show only one pond and no ponds were present in a 1980 aerial photograph. Figure 2 shows the approximate maximum areal extent of the ponds based on the 1968, 1970, 1976 and 1978 aerial photographs which were enlarged to a scale of between approximately 1:100 to 1:200. Figure 7 is an enlargement of the 1970 aerial photograph which shows the location of these ponds.

It is noted that boring location B-1 appears to be slightly outside of the two pond areas, but this may be the result of the location being approximate since the borings were not surveyed. With the possible exception of sample location B-1, there is no analytical data of the subsurface materials within the approximate area of the former ponds.

It should be noted, however, that materials similar in physical and chemical characteristics to those identified in area B-1 may not be found throughout the area of the two former ponds. A review of test pit and boring logs completed within this general area (e.g., TP-15, P-4, and MW-7D) did not indicate the presence of a sludge-like material as described in the boring log for B-1. In addition, as part of the preliminary feasibility study, four locations were excavated in 1989 in the vicinity of piezometer P-4 and identified the presence of fill and debris. Only one location (60 feet south of P-4) yielded a sludge-like material at a depth interval of 2 to 6 feet below ground surface which may have been within the pond areas. As a result of these observations, it is also possible that the pond areas have primarily been filled with C&D debris and that the "hot-spot" material is not present throughout the area of the former ponds but is present within a smaller, discrete area around boring B-1.

Therefore, it is considered necessary to investigate the area around B-1 as well as the two former pond areas to define the areal extent of the potential "hot-spot". A focused investigation in the vicinity of B-1 is required to address:

- the presence and areal extent of sludge-like material encountered at B-1;
- physical characterization of subsurface materials; and,
- chemical characterization of subsurface materials.

#### **4.1.2 Technical Approach to Address Data Gap**

A geophysical survey will be used to investigate the two former pond areas and the B-1 area. This investigation will attempt to define the subsurface material characteristics, approximate boundaries of the two former pond areas, and location and approximate boundaries of the B-1 area. A boring program will be used to investigate the area around boring location B-1 area using the results of the geophysical survey to efficiently focus the placement of the borings. Details of the geophysical methods and boring programs proposed are presented in Section 5.0.

Once the data from the geophysical survey has been collected and interpreted, if discrete area(s) are identified that would suggest the possible presence of significant sludge-like material within the two former pond areas, a boring program will be used to investigate the area. Blow counts and

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subsurface material descriptions will be recorded for each boring and samples will be collected for laboratory analyses as described in more detail in Section 5.0.

## **4.2 Geotechnical Properties**

### **4.2.1 Identification of Data Gap**

As discussed in Section 3.3, the geotechnical properties of the meadow mat layer and upper glaciolacustrine varved unit are an important consideration in evaluating the potential implementation of "hot-spot" excavation. Some of the "hot-spot" remediation alternatives being considered in the FFS include excavation prior to off-site disposal and/or treatment. Therefore, the geotechnical properties of the materials underlying the potential "hot-spot" area need to be better defined for the purpose of evaluating "hot-spot" remediation alternatives in the FFS.

### **4.2.2 Technical Approach to Address Data Gap**

Borings will be advanced to the bottom of the FOU fill at several locations during the "hot spot" investigation described in Section 4.1. Shelby tube samples will be collected of the underlying material (meadow mat and glaciolacustrine varved unit) for geotechnical property analyses. Details with respect to boring installation and sample collection and geotechnical analyses are provided in Section 5.0.

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## 5.0 SCOPE OF WORK

The Scope of Work for the FFS investigation will focus on investigating the potential "hot-spot" area and includes the following:

1. Geophysical Surveys: in the areas of boring location B-1 and the two former ponds;
2. Soil Boring Program: to define characteristics (areal extent, subsurface material types, and chemical constituent concentrations) within the potential "hot-spot" area at location B-1 and, based on the geophysical survey results, similar locations within the two former pond areas; and,
3. Geotechnical Sample Collection and Analysis: to provide geotechnical parameters for the meadow mat layer and upper glaciolacustrine varved unit below the potential "hot-spot" area.

The following sections provide an overview of the scope of work. Detailed procedures to perform the field work are described in the Sampling, Analysis, and Monitoring Plan (SAMP) provided in Appendix C. All field work will be conducted in accordance with the Health and Safety Plan (HASP) as discussed in Section 5.3. Quality assurance and data validation procedures are discussed in the Quality Assurance Project Plan (QAPjP) provided in Appendix D. All laboratory analysis results will be validated according to USEPA Region II Standard Operating Procedures.

### 5.1 Potential "Hot Spot" Area Characterization

As discussed in previous sections, focused remediation of the sludge-like materials and corresponding PCB concentrations identified in boring B-1 will be effective in significantly reducing the estimated overall Site risk. This area has been identified as a potential "hot-spot" for the Site. Further, two ponds, adjacent to the B-1 area, have existed historically and may or may not contain similar types of materials. Therefore, the potential "hot-spot" investigation has the following two components:

1. Better definition of the characteristics of the area around B-1:
  - areal extent;
  - characterization of subsurface materials; and,
  - identification of chemical characteristics.
2. Define characteristics of the two former pond areas:

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- presence and location of sludge like material ;
  - characterization of subsurface materials; and,
  - identification of chemical characteristics of sludge like material.

### 5.1.1 Proposed Geophysical Survey

A Site-wide geophysical survey was previously performed in 1987 which used electromagnetic (EM-31) and proton magnetometer (EG&G 856) techniques to detect possible presence of buried ferrous material and contamination beneath the Site (DELTA, 1987). The results of the investigation identified thirty-nine high and low magnetic anomalies indicating possible areas of ferrous material. Nine anomalous conductivity zones were interpreted as indications of soil contamination. These results generally indicate a site-wide distribution of debris at the Site. The soil boring and test pits installed during the remedial investigation verified the site-wide nature of debris. While the geophysical survey conducted in 1987 appears to have met its intended objective at the time, it is considered to be a general, initial Site survey. Therefore, a more detailed geophysical survey will focus on the vicinity of boring B-1 and the two former pond areas.

Geophysical surveying will be used for defining the approximate location and boundary of the B-1 area and will provide a more in-depth understanding of the subsurface material within the two former pond areas. Figure 8 shows the approximate area in which the geophysical survey will be conducted.

The proposed geophysical survey will utilize two techniques: frequency domain electromagnetics (FEM), and ground penetrating radar (GPR). These methods measure responses from the subsurface which vary depending on the electrical properties of the subsurface, electrical conductivity in the case of FEM and dielectric permittivity in the case of GPR. The survey grid system will be much more refined than previously employed (e.g. closer station and line spacing). These two methods will assist in determining the extent of areas consisting of fine grained material and sludge and either large or small C&D debris. The geophysical data will be assessed in the field to determine the location and extent of anomalies which may correspond to sludge areas. This assessment will be discussed with the USEPA Oversight Contractor and/or USEPA Project Manager, as appropriate, to determine the location of the confirmatory borings required. The following paragraphs discuss the two geophysical survey techniques and detailed procedures are described further in Appendix C.



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***Frequency Domain Electromagnetics***

FEM will be employed using the Geonics EM-31, a vertical dipole instrument with an operating frequency of about 10 KHz and a coil spacing of about 12 feet. The instrument measures two components of an electromagnetic field induced in the subsurface by the transmitter, and modified by the subsurface materials prior to being picked up at the receiver.

The two in-phase and quadrature components are measured at the receiver. The quadrature component responds primarily to poor conductors such as earth materials, and is calibrated in units of terrain conductivity (milliseimens/meter). The in-phase component responds primarily to good conductors such as ferrous metal objects and is calibrated in parts per thousand (ppt). The instrument has a maximum depth of penetration of about 13 feet. Measurements will be made over the site using a 6-foot line spacing and 3-foot station spacing.

The two components of the data resulting from this survey will be contoured and correlated to test pit and borehole information where possible. It is worth noting that the upper 2 to 3 feet of the Site has been altered as a result of IRM construction and regrading, and therefore correlations to some existing test pit and boring logs may be difficult. The extent of areas primarily consisting of either: fine grained material or sludge, and large and small debris, will be inferred based on differences in the electric properties of these materials and the observed quadrature and in phase responses.

***Ground Penetrating Radar***

GPR will be employed using the Sensors and Software Pulse Ekko IV system. One GPR antenna transmits an electromagnetic pulse into the subsurface and another antenna receives pulses reflected from objects and stratigraphic horizons in the subsurface.

With a fixed antenna separation, GPR traces will be acquired along each survey line at intervals of about 4 inches to produce a subsurface cross section. On these cross sections, subsurface interfaces (such as the top of sludge layers) and features (such as large debris fragments, metal objects, and fine grained material) will be identified and interpreted.

Both 100 and 200 MHz antenna frequencies will be tested in the field. Higher frequency antennas have better vertical resolution but penetrate to a lesser depth than do lower frequency

antennas. The antenna which produces the best results at this site will be used; quite possibly both antennas will be used on different parts of the site, depending on the subsurface conditions. The maximum anticipated depth of GPR penetration, based on present knowledge of site conditions, is estimated to be about 12 feet.

#### **5.1.2 B-1 Area Boring Investigation**

Prior to the investigation, the estimated location of B-1 shown on Figure 8 will be marked in the field to provide a point of reference. The geophysical survey results (see Section 5.1.1) will be utilized to refine the likely location of B-1 prior to initiating the boring investigation. A soil boring will be completed at the estimated location of B-1 to verify the existence of the sludge-like material. The boring program will then be expanded outward approximately 20 feet to assess the areal extent of the sludge-like material (borings GB-01 through GB-04).

Split-spoon samples will be collected continuously at each boring location and samples from each interval will be placed in laboratory containers for possible laboratory analyses. Each split-spoon sample, as well as drill cuttings, will be logged, standard penetration tests (blow counts) recorded, and drilling resistance noted. In addition, visual observations will be recorded on the soil boring logs (discoloration, staining, layering, odors, etc.). Split-spoons will also be scanned with a photoionization detector (PID) and/or flame ionization detector (FID) organic vapor analyzer. The borehole will be advanced until natural ground surface is encountered.

If sludge like material is identified, samples will be submitted for Target Compound List and Target Analyte List (TCL/TAL; minus cyanide) analyses. In addition, select samples will be collected and submitted for pH, moisture content, grain size analysis, total organic carbon (TOC), and oil and grease. A minimum of one sample of the sludge material from each boring will be collected and submitted for laboratory analysis. If the sludge material is greater than 4 feet in thickness in a given boring (for borings GB-01 through GB-04), then two samples from each boring will be collected and submitted for analysis (maximum of eight samples). Drilling and sampling procedures are described further in Appendix C.

Should borings GB-01 through GB-04 identify sludge-like materials, similar to that encountered at boring B-1, additional borings will be installed approximately 20 feet outward to assess the areal extent of the material. Sampling will be performed similar to that described above except that only

one sample of the sludge material from each of these borings, if encountered, will be sent to the laboratory for analyses (maximum of four additional samples).

Additional borings may be required to complete the delineation of the B-1 area. Delineation will be considered complete when a soil boring does not encounter sludge materials. Because the chemical characteristics of the sludge material will be well defined based on the sample analyses described above, additional borings used to complete the delineation of the boring B-1 area will focus on defining the physical characteristics of subsurface materials. Samples will not be sent to the laboratory for analyses from any additional borings.

It should be noted that the initial borehole (based on the estimated location and geophysics) may not encounter sludge-like material, and an expanded drilling program may be required. If the initial boring does not encounter sludge-like material similar to B-1, the center of the boring program may be adjusted based on the geophysics results or may be expanded outward from the initial point in each direction at 20 foot intervals, for a maximum of 40 feet in each direction (an area of 80 feet x 80 feet). During this investigation, samples from each split-spoon will be logged, screened and treated as though the sample will be submitted to the analytical laboratory for TCL/TAL minus cyanide analysis (e.g., placed in laboratory sample jars and preserved in a cooler). At the end of each day, the field supervising geologist/engineer and USEPA oversight contractor will determine the appropriate samples to submit to the laboratory for analysis based on field observations, percent of fines, staining, organic vapor readings, etc. (an apparent worst case sample).

If the sludge-like material is encountered in any of these borings, the steps described initially for borings GB-01 through GB-04 and the possible subsequent borings for delineation purposes will be followed as appropriate. Figure 8 shows the approximate locations of borings which will be used to investigate the B-1 area. Please note that these locations are for presentation purposes only and are based on the B-1 area being verified at the first boring location. In summary, the number of soil borings and samples collected will depend on how many borings encounter sludge material. If sludge material is initially encountered, it is anticipated that the number of samples of the sludge material submitted for analyses could range between 1 and 12. If sludge material is not encountered in any soil boring, the number of samples submitted of the FOU fill for analyses could range between 4 and 8. The field program will require flexibility and any key decision will be made with the concurrence of the USEPA oversight contractor and/or USEPA Project Manager as appropriate.

The location of all borings will be staked during the investigation. When the investigation is completed, each location will be surveyed by a New Jersey licensed professional land surveyor.

### **5.1.3 Former Pond Area Investigation**

The results of the geophysical survey (Section 5.1.1) and the boring program for the B-1 area (Section 5.1.2) will be utilized to determine the need for additional boring investigations in the former pond area. This determination will be based on anomalies identified by the geophysical survey that have a signature consistent with that found in the B-1 area indicating a fine grained or sludge like material. Only anomalies of significant size will be investigated and the investigation will only include a verification boring to provide a physical description of the material. If the material is similar to material found in the B-1 area, a sample will be collected and submitted to a laboratory for TCL/TAL minus cyanide analyses, pH, moisture content, grain-size distribution, TOC, and oil and grease testing. The field program will require flexibility and any key decisions will be made with the concurrence of the USEPA oversight contractor and/or USEPA Project Manager as appropriate.

If a boring program is necessary, similar to the B-1 area investigation, split-spoon samples will be collected continuously at each boring location and samples from each interval will be placed in laboratory containers for possible chemical analyses. Each split-spoon sample, as well as drill cuttings, will be logged, standard penetration tests (blow counts) recorded, and auger resistance noted. Split-spoons will also be scanned with a PID and/or FID organic vapor analyzer.

Similar to the B-1 area investigation, the location of all borings will be staked during the investigation. When the investigation is completed, each location will be surveyed by a New Jersey licensed professional land surveyor.

### **5.2 Geotechnical Investigation in "Hot-Spot" Area**

Limited information is available regarding the geotechnical properties of the meadow mat layer and the upper glaciolacustrine varved unit. As part of the evaluation of "hot-spot alternatives", side slope stability must be evaluated to determine the maximum slope of excavation possible consistent with protecting the integrity of the slurry wall during any "hot-spot" area excavation activity. Therefore, the objective of this investigation is to determine the geotechnical parameters of the

meadow mat layer and upper glaciolacustrine varved unit through the collection of relatively undisturbed samples for geotechnical analysis. Each analysis will include moisture content (ASTM D2216), Atterberg limits (ASTM D4318), and consolidated undrained triaxial compression testing with pore water pressure measurement (ASTM D4767). Samples of the meadow mat and glaciolacustrine varved unit will be collected from two borings completed as part of the potential "hot spot" area investigation. The location of the borings will depend on the thickness of the meadow mat (a minimum of three feet is desirable) encountered in each boring. One Shelby tube sample of each unit (meadow mat and varved unit) will be attempted. The most representative sample of each unit, based on integrity and recovery, will be tested. No more than 2 feet of the glaciolacustrine varved unit will be penetrated and the clay will be tremie grouted to close the sample hole. Drilling and sampling procedures are described further in Appendix C.

### **5.3 Health and Safety Considerations**

All field work will be conducted in accordance with the Health and Safety Plan (HASP) provided in Appendix D of the Work Plan Amendment for the Off-Property Investigation (Golder Associates, December 1995). The initial level of protection for all work involved with the drilling program on-Site will be Level D-2. All necessary equipment for possible upgrade to Level C respiratory protection and personal protective equipment (PPE) will be kept on-Site for all personnel involved with the on-Site work. If Level B respiratory protection and PPE is necessary, all work will immediately cease and engineering controls will be implemented until the necessary equipment and personnel can be mobilized on-Site to ensure the work will be completed in a safe manner. The level of protection for all work associated with the non-intrusive geophysical survey will be Level D-1.

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## 6.0 ACCESS

All proposed soil borings are located on the 216 Paterson Plank Road property which will not require any property access agreements. As a contingency, access agreements will be made with the trucking company southeast of the Site to gain physical access from their property. Access onto the geomembrane for the drilling rig will require placement of a ramp over the drainage channel that circumscribes the Site. Access to the soil boring locations will also require careful maneuvering around the above ground piping or, if necessary, placing a ramp over the piping or temporarily removing the lines. The USEPA will be immediately notified of any impact or damage to the dewatering system. If any repairs to the dewatering system are necessary, the USEPA will be notified prior to commencing the work. Upon completion of the field work a detailed survey of the geomembrane will be completed identifying any areas that have been compromised. All damaged areas will be repaired to meet the specifications outlined in Section 4.2 of the Operations and Maintenance Plan (Canonic Environmental, July 19, 1991).

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## 7.0 MEETINGS/REPORTING

A kick-off meeting is proposed with the Agencies prior to commencing field work. The purpose of this meeting is for Agency representatives to meet with the Investigation Leader to review the field program objectives and technical details and discuss the schedule for field activities. Additional meetings or conference calls will be held as necessary throughout the Investigation.

The data from this investigation will be evaluated and utilized during Phase II of the FFS - Detailed Analysis of Remedial Alternatives. A concise field investigation report will be presented as an Appendix to the Draft FFS Report. It is anticipated that substantive findings of the Investigation will have already been discussed and agreed with the Agencies through meetings or conference calls prior to the submittal which will facilitate the use of the data during Phase II of the FFS and expedite the review and comment period.

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## 8.0 SCHEDULE

The proposed schedule for the FFS Investigation is presented on Figure 9. This schedule falls within the overall FFS schedule presented in the Final Work Plan Amendment (Golder Associates, December 1995) which provided for a 5-month contingency for additional sampling/treatability studies, if required. Based on the results of Phase I of the FFS, the FFS schedule has been revised to include the proposed additional sampling. As noted previously, the need for treatability studies will be re-evaluated following this investigation and could impact the schedule.

The start of field work is contingent on approval from the Agencies and the schedule for management of Investigation Derived Waste (IDW) currently on Site. A 2-1/2 month period is allotted for conducting the fieldwork, chemistry and geotechnical analyses, and evaluation of the data. A 4-month period following the completion of the investigation is allotted to conduct a detailed analysis of alternatives and submit a Draft FFS Report. A 3-month comment/response period is envisioned following submittal of the Draft FFS Report which includes a 1-month Agency review period and 2-month period for response and submittal of the Final FFS Report.



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- United States Environmental Protection Agency, 1990. "Administrative Order Index No. II CERCLA-00116," September 28, 1990.
- United States Environmental Protection Agency, 1988. "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA," OSWER Directive 9355.3-01, October 1988.
- United States Environmental Protection Agency, 1985. "Administrative Order Index No. II CERCLA-60102," October 23, 1985.
- United States Environmental Protection Agency, 1985. "Administrative Order on Consent Index No. II CERCLA-50114," September 30, 1985.

\\gai\_mtl1\projects\document\projects\943-6222\fs-wp\revwkpln.doc

TABLE 1

**CONSTITUENT DETECTION SUMMARY  
FOU FILL - FOCUSED FEASIBILITY STUDY  
216 PATERSON PLANK ROAD SITE**

Constituent	Number of Detections above PRG (per 17 samples)		Total
	Surficial Soil (0 to 2 feet)	Lower Soil to 6 feet)	
Trichloroethylene	1	2	3 of 34
Tetrachloroethylene	3	5	8 of 34
Benzo(a)anthracene	0	1	1 of 34
Benzo(b)fluoranthene	2	2	4 of 34
Benzo(a)pyrene	9	4	13 of 34
Dibenzo(a,h)anthracene	1	0	1 of 34
Indeno(1,2,3-CD)pyrene	1	1	2 of 34
PCBs (all arochlors)	5-4**	4-3**	9-7 ** of 34
Aldrin	1	1	2 of 34
Dieldrin	5	2	7 of 34
Arsenic	13*	12*	25 of 34
Lead	8-2**	8-5**	16-7** of 34

\* Reduces to 3 based on background levels of Arsenic as per NJDEP Draft Soil Cleanup Standards

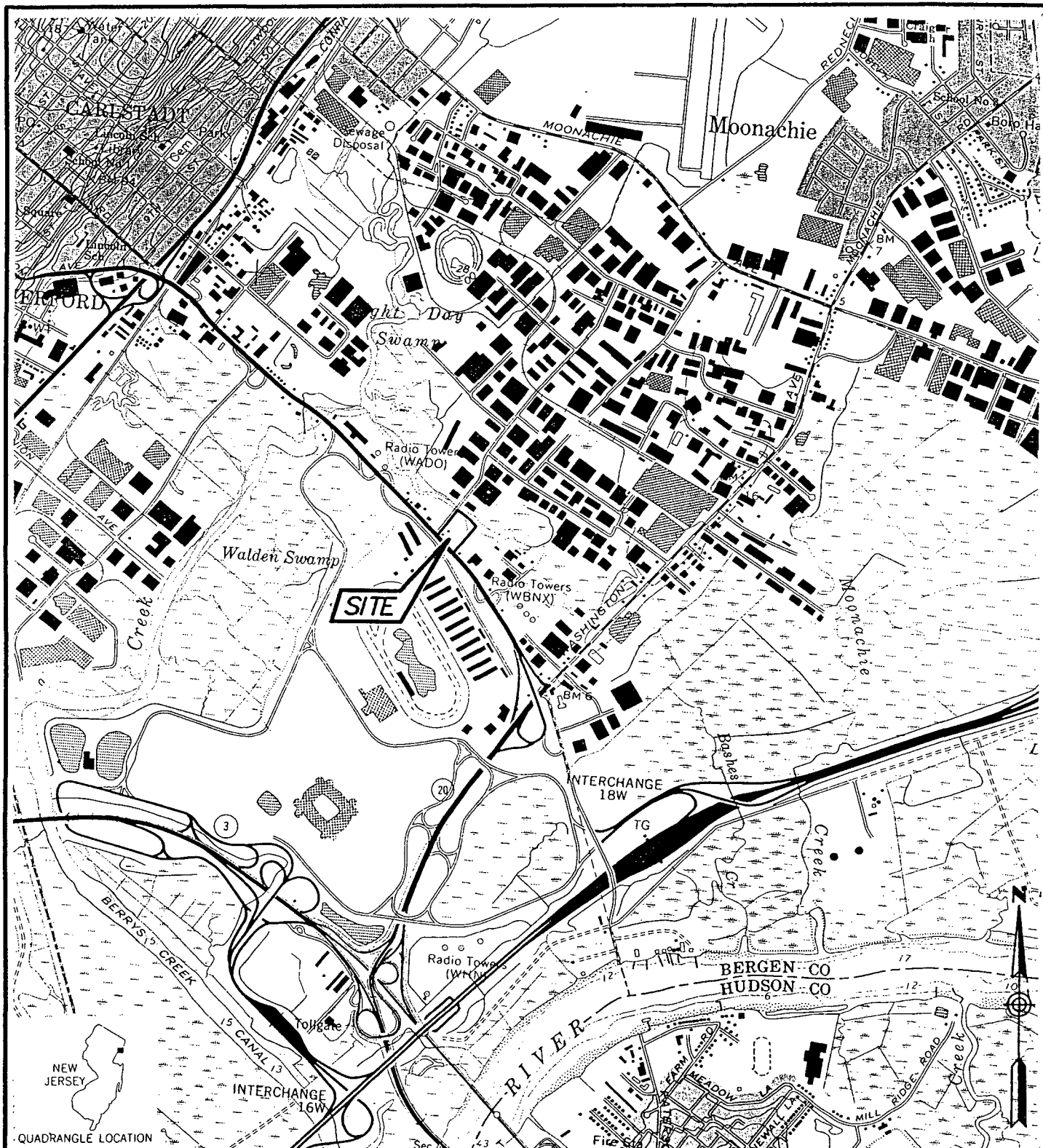
\*\* The PRG range for PCBs is 10-25 mg/kg and for lead is 500-1,000 mg/kg. Therefore the number of detections above the PRG for PCBs and lead are shown as a range.

**TABLE 2**  
**HOT SPOT ANALYSIS**  
**FOU FILL - FOCUSED FEASIBILITY STUDY**  
**216 PATERSON PLANK ROAD SITE**

Hot Spot Analysis Scenario	Estimated Residual Risk (HI/TELCR)	Major Constituents Contributing to Estimated Residual Risk
Baseline (BRA scenario)	423/9.0e-02	PCBs (416/8.7e-02)
		PCE (1.8/2.7e-04)
		Aldrin (2/3.2e-04)
		Dieldrin (1.3/3.0e-04)
		Carcinogenic PAHs (0/1.9e-04)
Minus Station B1	10/2.1e-03	PCBs (4.4/9.3e-04)
		PCE (1.8/2.7e-04)
		Aldrin (2/3.2e-04)
		Dieldrin (1.3/3.0e-04)
		Carcinogenic PAHs (0/1.9e-04)
Minus Stations B1 and MW-3S	8.5/1.7e-03	PCBs (2.7/5.6e-04)
		PCE (1.8/2.7e-04)
		Aldrin (2/3.2e-04)
		Dieldrin (1.3/3.0e-04)
		Carcinogenic PAHs (0/1.9e-04)
Minus Stations B1 and B6	6.9/1.5e-03	PCBs (4.4/9.3e-04)
		PCE (1.8/2.7e-04)
		Mercury (1.7e-01/0)
		Nitrobenzene (1.7e-01/0)
		Carcinogenic PAHs (0/1.9e-04)
Minus Stations B1, B2, B6, and MW-3S	3.1/8.7e-04	PCBs (2.7/5.6e-04)

**NOTES:**

1. Residual risk estimates based on Baseline Risk Assessment (Clement Associates, 1990).
2. HI: Hazard Index (non-carcinogenic)  
TELCR: total excess lifetime cancer risk



## REFERENCE

- 1.) USGS 7.5 MINUTE WEEHAWKEN QUADRANGLE, NEW JERSEY - NEW YORK, DATE 1967, PHOTOREVISED 1981.

APR 03 1996  
 2000 0 2000  
 scale feet

JOB No.:	943-6222	SCALE:	AS SHOWN
DR BY:	WCM	DATE:	02/21/96
CHK BY:	SDM	FILE No.:	NJ03-438
REV BY:	PSL	DR SUBTITLE:	09

## SITE LOCATION MAP

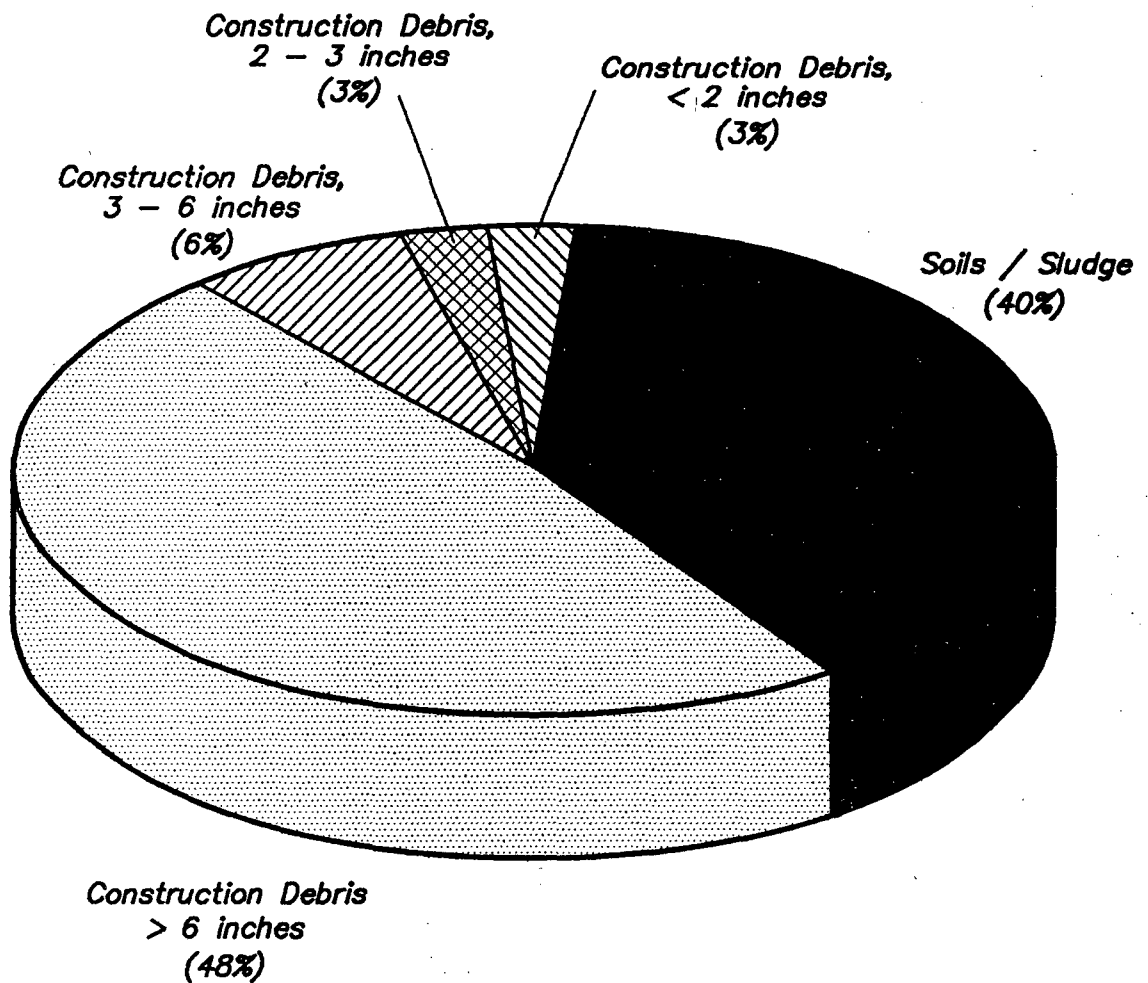
**Golder Associates**

216 PATERSON PLANK ROAD SITE

FIGURE

1

101042



APR 03 1996

JOB No.:	943-6222	SCALE:	N/A
DR BY:	JSG	DATE:	02/21/96
CHK BY:	Som	FILE No.:	NJ03-444
REV BY:	Pat	DR SUBTITLE:	09

## SIZE DISTRIBUTION OF FOU FILL

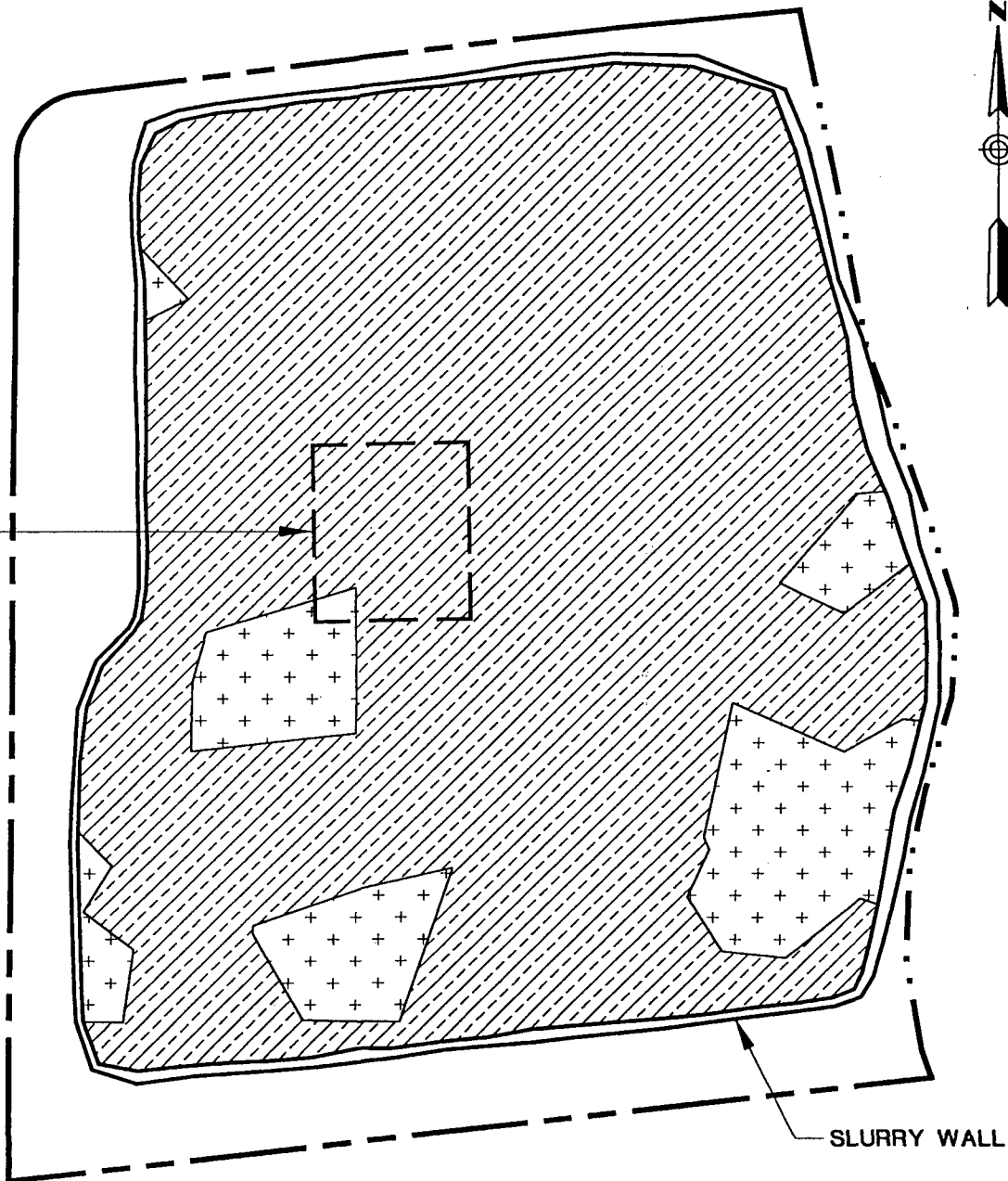
**Golder Associates**

216 PATERSON PLANK ROAD SITE

FIGURE **3**

101043

APPROXIMATE  
LOCATION OF  
SLURRY  
HYDRATION  
POND



APR 03 1996

## NOTES

- 1.) INFORMATION OBTAINED FROM 23 TEST PITS AND 49 SOIL BORINGS AND INTERPOLATED USING THIESSEN POLYGON TECHNIQUES.

Pattern	C&D Debris Observation from Test Pit Study	Blow Counts from Boring Study
	C&D DEBRIS IDENTIFIED IN TEST PIT	BLOW COUNTS >30 IN SOIL BORING
	NO C&D DEBRIS OBSERVED	ALL BLOW COUNTS < 30

JOB No.:	943-6222	SCALE:	1"=100'
DR BY:	MRM	DATE:	04/03/96
CHK BY:	<i>SDM</i>	FILE No.:	NJ03-448
REV BY:	<i>BSL</i>	DR SUBTITLE:	09

**AREAL EXTENT  
OF C&D DEBRIS, 0-6 FEET DEPTH  
(PRE-IRM CONSTRUCTION)**

**Golder Associates**

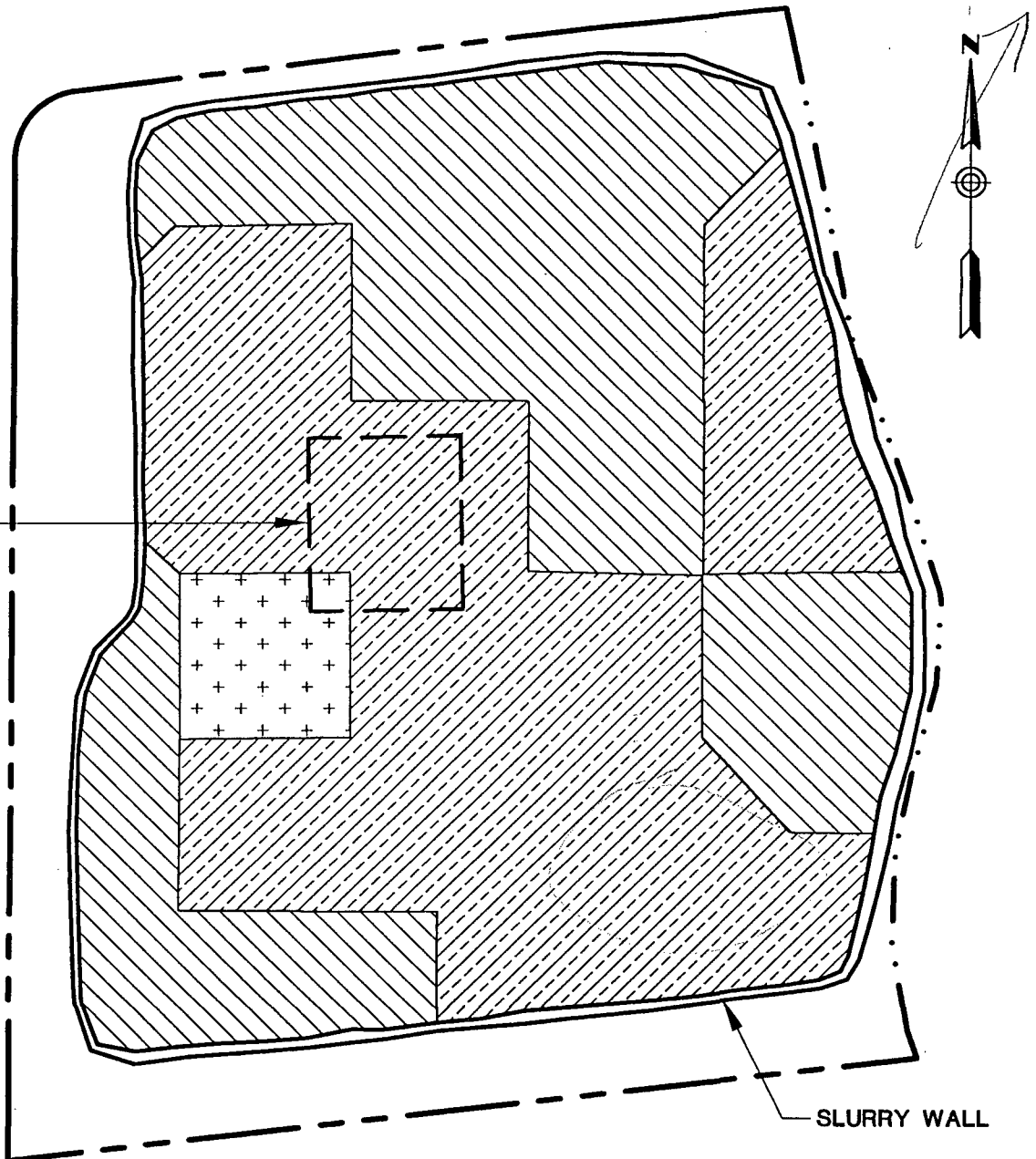
216 PATERSON PLANK ROAD SITE

FIGURE

**5**

101044

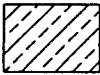

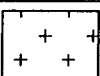
APPROXIMATE  
LOCATION OF  
SLURRY  
HYDRATION  
POND



APR 03 1996

## NOTES

- 1.) INFORMATION OBTAINED FROM 23 TEST PITS AND INTERPOLATED USING THIESSEN POLYGON TECHNIQUES.

Pattern	Particle Size Range (based on Test Pit data)
	GREATER THAN 6 INCH C&D DEBRIS OBSERVED
	LESS THAN 6 INCH C&D DEBRIS OBSERVED
	NO C&D DEBRIS OBSERVED

JOB No.:	943-6222	SCALE:	1"=100'
DR BY:	MRM	DATE:	04/03/96
CHK BY:	SDM	FILE No.:	NJ03-449
REV BY:	BL	DR SUBTITLE:	09

## AERIAL EXTENT AND SIZE DISTRIBUTION OF C&D DEBRIS, 0-6 FEET DEPTH (PRE-IRM CONSTRUCTION)

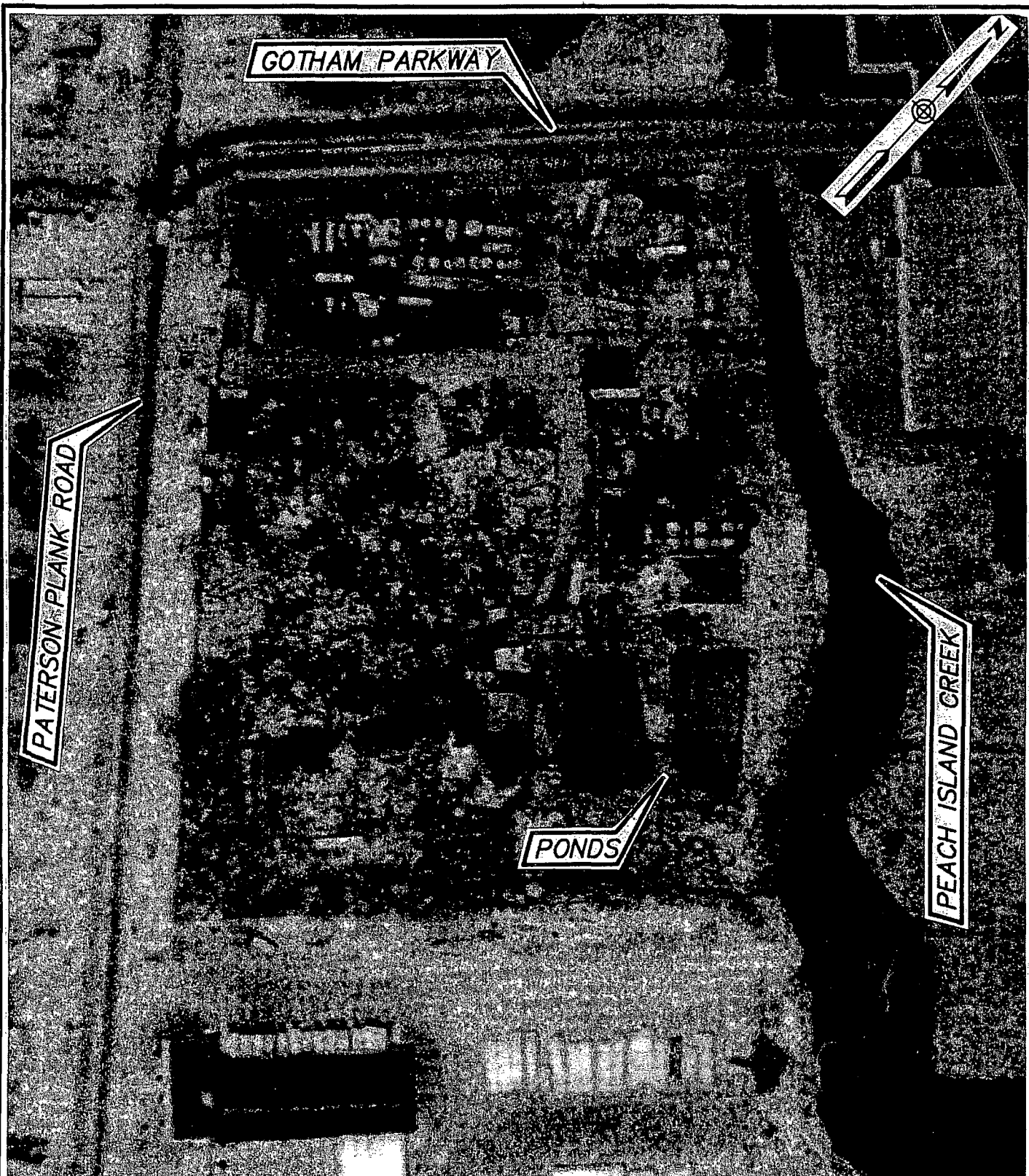
**Golder Associates**

216 PATERSON PLANK ROAD SITE

FIGURE

**6**

101045



# REFERENCE

1.) MAY 29, 1970 AERIAL PHOTOGRAPH ENLARGED TO A SCALE AT APPROXIMATELY 1:100.

100 0 100  
approximate scale feet

JOB No.:	943-6222	SCALE:	AS SHOWN
DR BY:	JSG	DATE:	02/21/96
CHK BY:	SOM	FILE No.:	NJ03-439
REV BY:	P&L	DR SUBTITLE:	09

## 1970 AERIAL PHOTOGRAPH

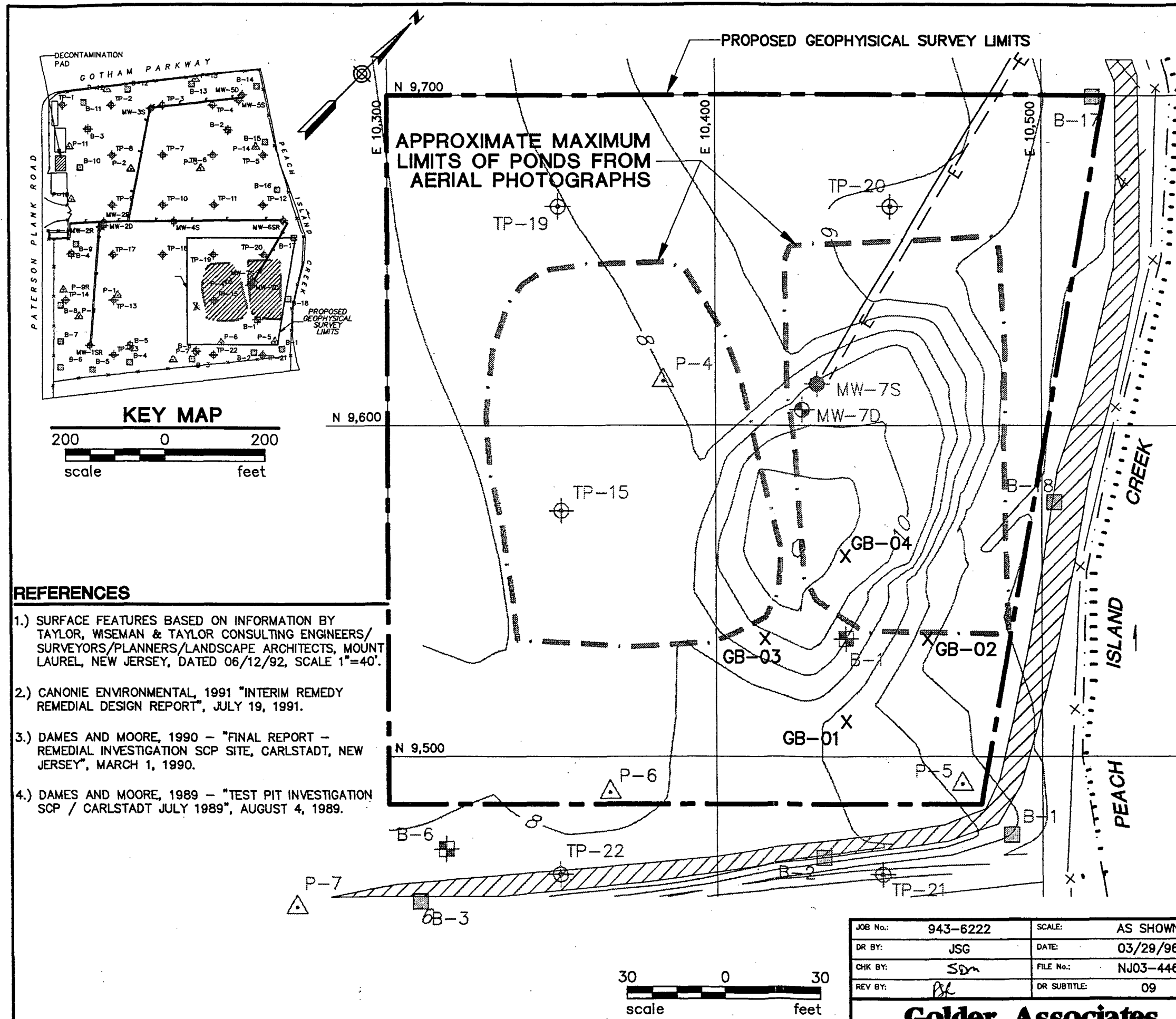
**Golder Associates**

216 PATERSON PLANK ROAD SITE

FIGURE **7**

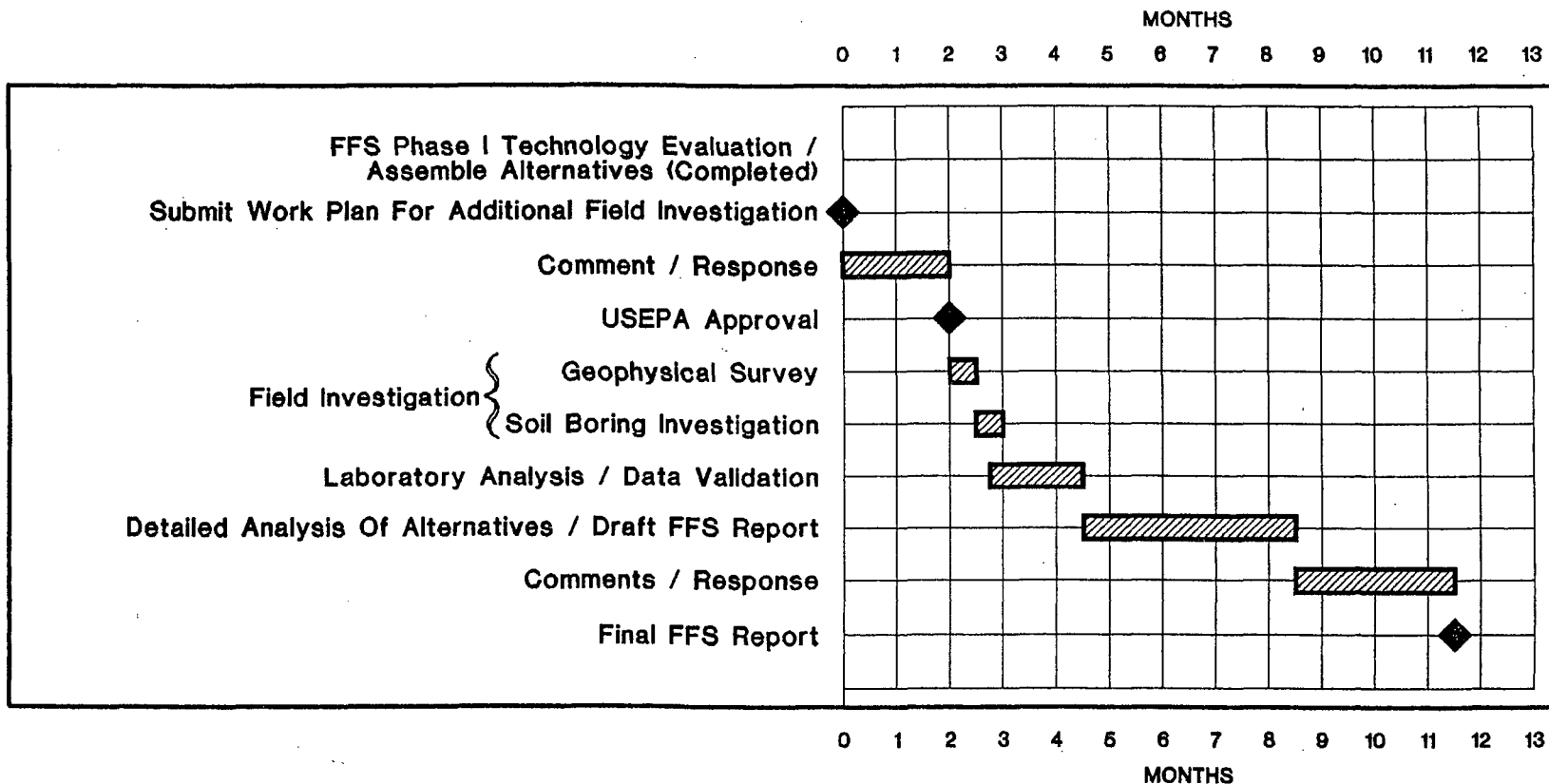
101046





JOB No.:	943-6222	SCALE:	N/A
DR BY:	JSG	DATE:	04/03/96
CHK BY:	SDM	FILE No.:	NJ03-445
REV BY:	BS	DR SUBTITLE:	09

**FFS PROJECT SCHEDULE**



APR 03 1996

NOTE: FIELD INVESTIGATION SCHEDULE IS SOMEWHAT DEPENDENT ON WEATHER CONDITIONS, ACCESS, SUBCONTRACTOR AVAILABILITY, EXTENT OF SOIL BORING PROGRAM, AND OTHER FACTORS BEYOND THE GROUP'S CONTROL.

**APPENDIX A**  
**Site Photographs**

CHK BY: *SDm*  
REV BY: *RF*

JOB No.: 943-6222  
SCALE: N/A

FILE No.: 6222-P  
DR ST: 09



PHOTOGRAPH No. 1 Backfilling Slurry Hydration Pond With Debris Excavated From The Slurry Wall Trench.

CHK BY: *SDM*  
REV BY: *RL*  
*131*

JOB No.: 943-6222  
SCALE: N/A

FILE No.: 6222-P  
DR ST: 09



PHOTOGRAPH No. 2 Debris Exposed During Silt Fence Installation.



CHK BY: SDW

JOB No.: 943-6222

FILE No.: 6222-P

REV BY: BL

SCALE: N/A

DR ST: 09



PHOTOGRAPH No. 3 Debris Encountered During Slurry Wall Excavation Activities On-Site.

CHK BY: *Sam*  
REV BY: *PSF*

JOB No.: 943-6222  
SCALE: N/A

FILE No.: 6222-P  
DR ST: 09



PHOTOGRAPH No. 4 Debris Pile Material Encountered During IRM Excavation On-Site.

CHK BY: SOM  
REV BY: fhe

JOB No.: 943-6222

FILE No.: 6222-P

SCALE: N/A

DR ST: 09



Goldier Associates

101054

PHOTOGRAPH No. 5 Debris Encountered Along Peach Island Creek. Debris Incorporated Into Final Site Grading.



CHK BY: *SDM*  
REV BY: *Pl*

JOB No.: 943-6222  
SCALE: N/A

FILE No.: 6222-P  
DR ST: 09



PHOTOGRAPH No. 6 Debris Along Peach Island Creek Prior To IRM. Debris Incorporated Into Final Site Grading.

CHK BY: *son*  
REV BY: *pl*

JOB No.: 943-6222

FILE No.: 6222-P

SCALE: N/A

DR ST: 09



PHOTOGRAPH No. 7 Segregation Of Clean Fill And Debris For Final Grading. Debris Incorporated Into Final Site Grading.

CHK BY: *SOM* JOB No.: 943-6222 FILE No.: 6222-P  
REV BY: *RL* SCALE: N/A DR ST: 09



PHOTOGRAPH No. 8 Debris Pile Located Southeast Of MW-4S Prior To The IRM Activities. Debris Incorporated Into Final Site Grading.



CHK BY: SDM  
REV BY: PGP

JOB No.: 943-6222

FILE No.: 6222-P

SCALE: N/A

DR ST: 09



PHOTOGRAPH No. 9 Application Of Stabilized Foam For Emission Control. Health And Safety Level B.

## APPENDIX B

### Preliminary Excavation Stability Analysis

## APPENDIX B

### SUMMARY OF PRELIMINARY EXCAVATION STABILITY CALCULATIONS

#### APPROACH

Preliminary slope stability calculations have been performed to assess potential limitations to excavation side slopes for remediation at the Paterson Plank Road Site. The calculations were performed to estimate a stable slopes angle for a temporary excavation condition to the bottom of the peat layer at the Site. The calculations were performed using the computer program STABL, which uses the Bishop method of slices to calculate static stability. In evaluating the results, it is judged that a factor of safety (FS) of 1.2 would be appropriate for a temporary excavation slope.

The subsurface stratigraphy input to the model was based on a subsurface profile developed from various test borings taken at the site. Geotechnical strength and weight values for the various strata were estimated based on published literature and experience values. The stratigraphy and geotechnical parameters are presented on Figure B1 (sheet 3) of the attached calculations.

Stability analyses were performed for slope angles of 2 horizontal to 1 vertical (2H:1V), 3H:1V and 4H:1V, considering both shallow and deep seated slope failure surfaces. Analyses were performed considering the effects of only the upper perched water table in the fill at elevation 3.5 feet MSL (to account for pumping), and the effects of both the upper perched water table in the fill at elevation 3.5 feet MSL and the lower varved clay groundwater table (high water table) taken at elevation 0 feet mean sea level (MSL).

#### RESULTS

The calculated factors of safety are summarized as follows:

	2H:1V Slope		3H:1V Slope		4H:1V Slope	
	Shallow	Deep	Shallow	Deep	Shallow	Deep
Two Water Tables	1.10	1.16	1.10	1.48	-	1.81
Single Water Table	-	0.96	1.10	1.24	-	1.47

#### CONCLUSIONS

1. Slopes excavated at 2H:1V or steeper would not be stable under temporary, short term construction conditions.
2. Slopes excavated at 3H:1V would be marginally stable under temporary, short term construction conditions.
3. Slopes excavated at 4H:1V would be stable under temporary, short term construction conditions.

Considering a 4H:1V side slope angle, an average 10 foot thickness of fill and meadow mat, and a 5 foot buffer zone to protect the slurry wall, approximately 16,000 cubic yards, or about 18% of the FOU fill within the slurry wall would have to be left in place to protect the slurry wall (see Figure B2).

## REFERENCES

1. Interactive Software Designs, Inc., 1994, "XSTABL - An Integrated Slope Stability Analysis Program for Personal Computers," Version 5.
2. Golder Associates, Inc., 1995, "FFS Site Characterization for the 216 Paterson Plank road NPL Site, Carlstadt, New Jersey," Golder Associates Project Number 943-6222.
3. Electric Power Research Institute, 1990, "Manual on Estimating Soil Properties for Foundation Design," EPRI EL-6800, Project 1439-6, Cornell University, Ithica, New York.

D:\PROJECTS\943-6222\FS-WP\APPX-B\STABLTU.DOC

# SHORT TERM STABILITY

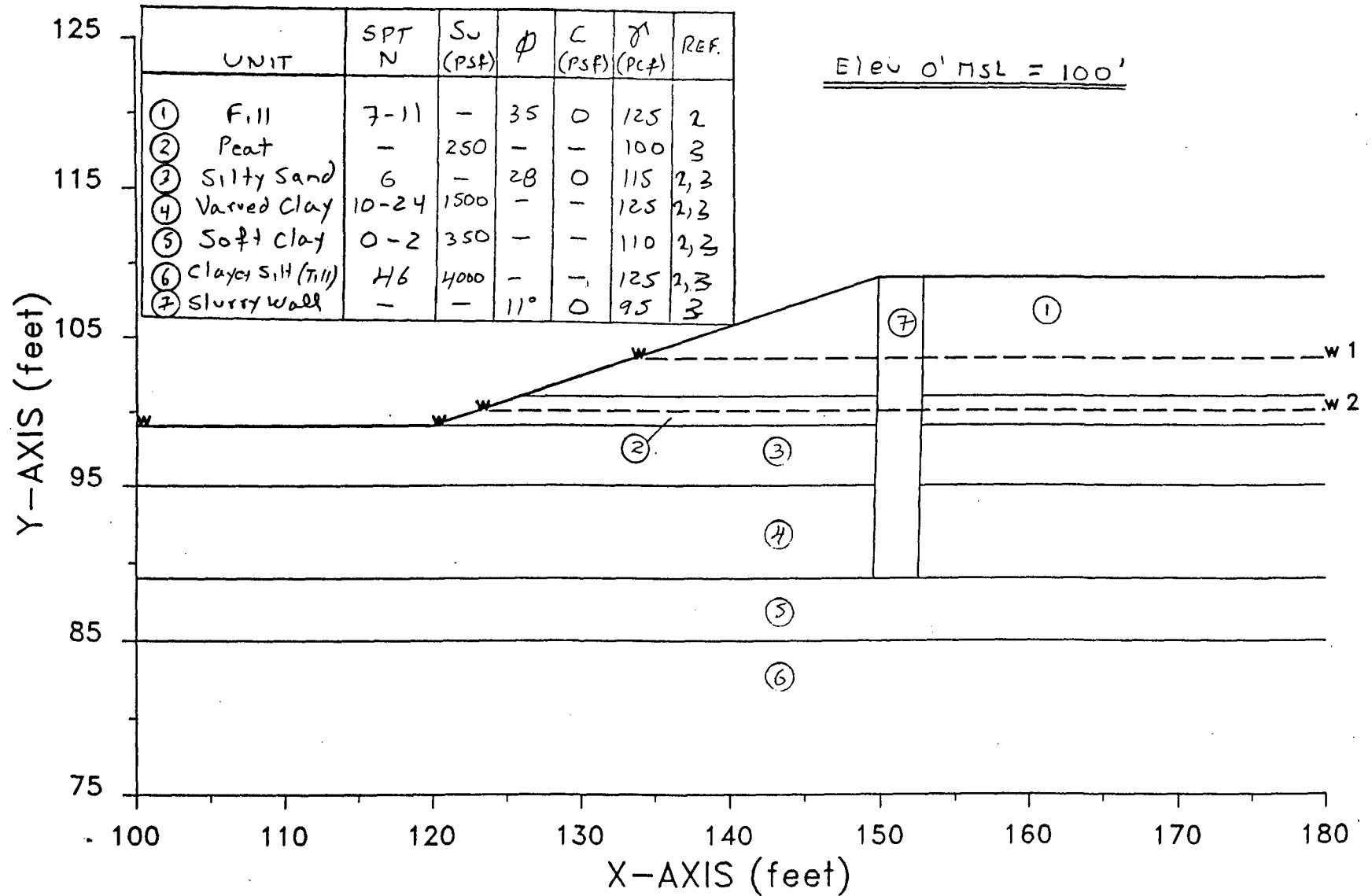
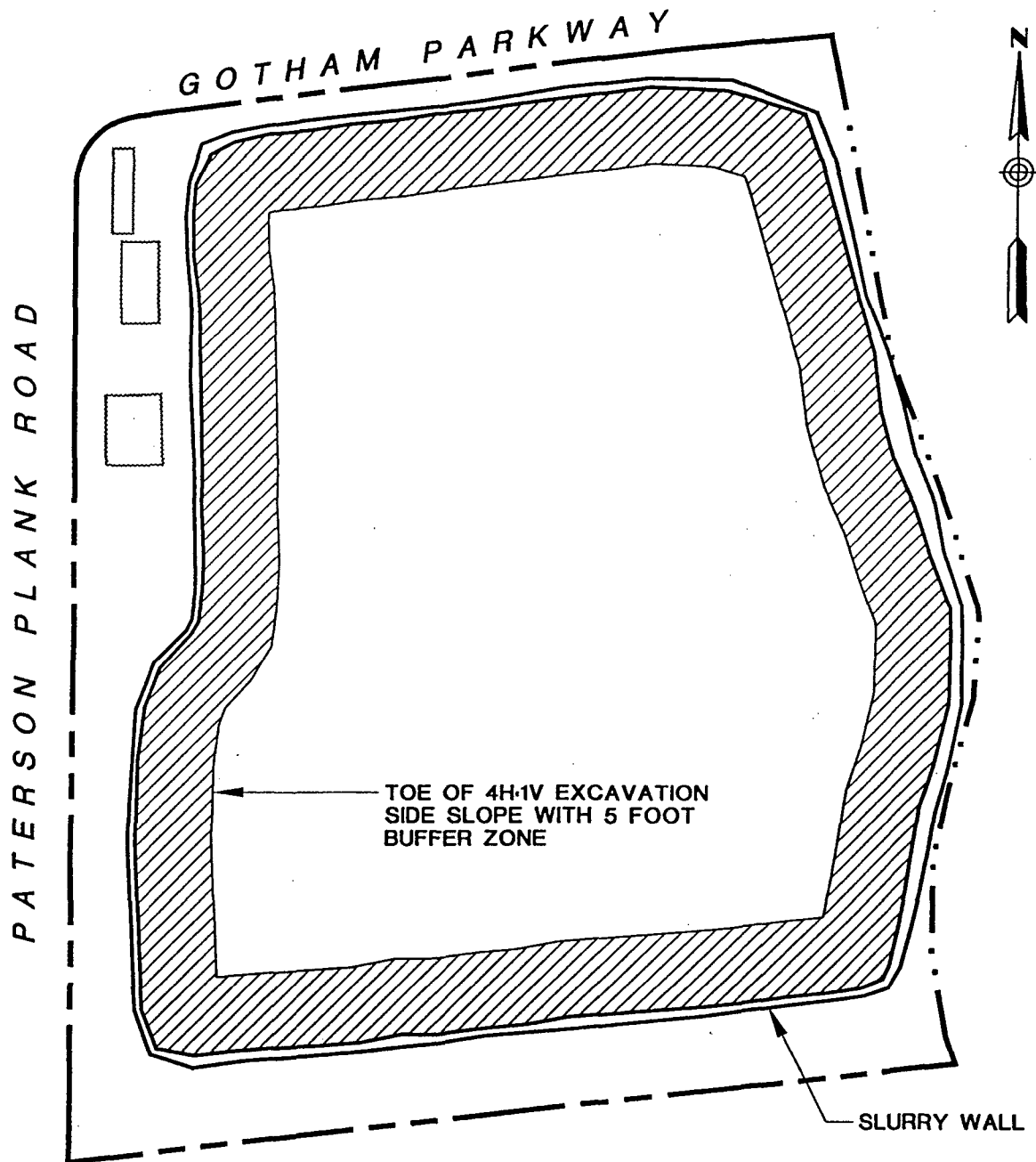


FIGURE B1





APR 03 1996

JOB No.: 943-6222	SCALE: 1"=100'	<b>4H:1V EXCAVATION SIDE SLOPE</b>
DR BY: MRM	DATE: 04/03/96	
CHK BY: <i>Sam</i>	FILE No.: NJ03-454	
REV BY: <i>[Signature]</i>	OR SUBTITLE: 09	
<b>Golder Associates</b>		216 PATERSON PLANK ROAD SITE <b>FIGURE B2</b>

Attachment A

References

Table 2-8

## TYPICAL SOIL UNIT WEIGHTS

Soil Type	Approximate Particle Size (mm)			Uniformity Coefficient D <sub>60</sub> /D <sub>10</sub>	Void Ratio		Normalized Unit Weight			
	D <sub>max</sub>	D <sub>min</sub>	D <sub>10</sub>		e <sub>max</sub>	e <sub>min</sub>	Dry, $\gamma_{dry}/\gamma_w$		Saturated, $\gamma_{sat}/\gamma_w$	
							Min.	Max.	Min.	Max.
<hr/>										
Uniform granular soil										
Equal spheres (theoretical)	-	-	-	1.0	0.92	0.35	-	-	-	-
Standard Ottawa sand	0.84	0.59	0.67	1.1	0.80	0.50	1.47	1.76	1.49	2.10
Clean, uniform sand	-	-	-	1.2 to 2.0	1.00	0.40	1.33	1.89	1.35	2.18
Uniform, inorganic silt	0.05	0.005	0.012	1.2 to 2.0	1.10	0.40	1.28	1.89	1.30	2.18
Well-graded granular soil										
Silty sand	2.0	0.005	0.02	5 to 10	0.90	0.30	1.39	2.04	1.41	2.28
Clean, fine to coarse sand	2.0	0.05	0.09	4 to 6	0.95	0.20	1.36	2.21	1.38	2.37
Micaceous sand	-	-	-	-	1.20	0.40	1.22	1.92	1.23	2.21
Silty sand and gravel	100	0.005	0.02	15 to 300	0.85	0.14	1.43	2.34	1.44	2.48
Silty or sandy clay	2.0	0.001	0.003	10 to 30	1.80	0.25	0.96	2.16	1.60	2.36
Gap-graded silty clay w. gravel or larger	250	0.001	-	-	1.00	0.20	1.35	2.24	1.84	2.42
Well-graded gravel, sand, silt, and clay	250	0.001	0.002	25 to 1000	0.70	0.13	1.60	2.37	2.00	2.50
Clay (30 to 50% < 2 $\mu$ size)	0.05	0.5 $\mu$	0.001	-	2.40	0.50	0.80	1.79	1.51	2.13
Colloidal clay (over 50% < 2 $\mu$ size)	0.01	10 $\mu$	-	-	12.00	0.60	0.21	1.70	1.14	2.05
Organic silt	-	-	-	-	3.00	0.55	0.64	1.76	1.39	2.10
Organic clay (30 to 50% < 2 $\mu$ size)	-	-	-	-	4.40	0.70	0.48	1.60	1.30	2.00

Note:  $\gamma_w = 62.4 \text{ lb/ft}^3 = 1 \text{ gm/cm}^3 = 0.983 \text{ t/m}^3 = 9.80 \text{ kN/m}^3$  (at STP conditions).

Source: Hough (26), pp. 34, 35.

Ref 3

Table 4-10  
APPROXIMATE  $s_u$  VERSUS N RELATIONSHIP

N Value (blows/ft or 305 mm)	Consistency	Approximate $s_u/p_a$	$S_u$ (Psf)
0 to 2	very soft	$< 1/8$	$< 250$
2 to 4	soft	$1/8$ to $1/4$	250 - 500
4 to 8	medium	$1/4$ to $1/2$	500 - 1000
8 to 15	stiff	$1/2$ to 1	1000 - 2000
15 to 30	very stiff	1 to 2	2000 - 4000
$> 30$	hard	$> 2$	$> 4000$

Source: Terzaghi and Peck (4), p. 347.

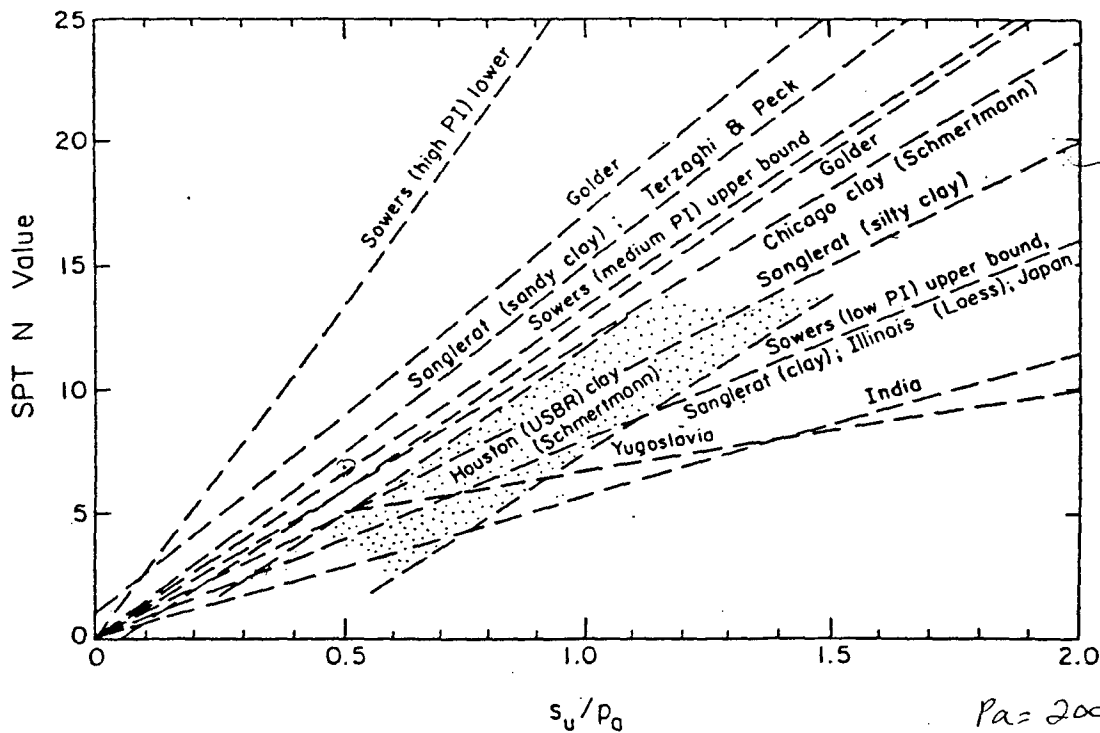


Figure 4-50. Selected Relationships Between N and  $s_u$

Source: Djoenaidi (71), p. 5-93.

$p_a = 2000$  psf  
(atmospheric pressure)

Ref 3

Table 4-3  
N VERSUS  $\bar{\phi}_{tc}$  RELATIONSHIPS

N Value (blows/ft or 305 mm)	Relative Density	Approximate $\bar{\phi}_{tc}$ (degrees)	
		(a)	(b)
0 to 4	very loose	< 28	< 30
4 to 10	loose	28 to 30	30 to 35
10 to 30	medium	30 to 36	35 to 40
30 to 50	dense	36 to 41	40 to 45
> 50	very dense	> 41	> 45

a - Source: Peck, Hanson, and Thornburn (12), p. 310.  
b - Source: Meyerhof (13), p. 17.

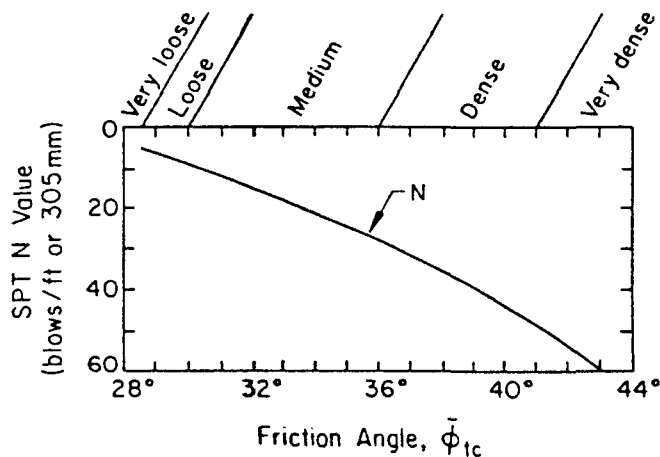


Figure 4-12. N versus  $\bar{\phi}_{tc}$

Source: Peck, Hanson, and Thornburn (12), p. 310.

can be approximated as follows:

$$\bar{\phi}_{tc} \approx \tan^{-1} [0.1 + 0.38 \log (q_c / \bar{\sigma}_{vo})] \quad (4-12)$$

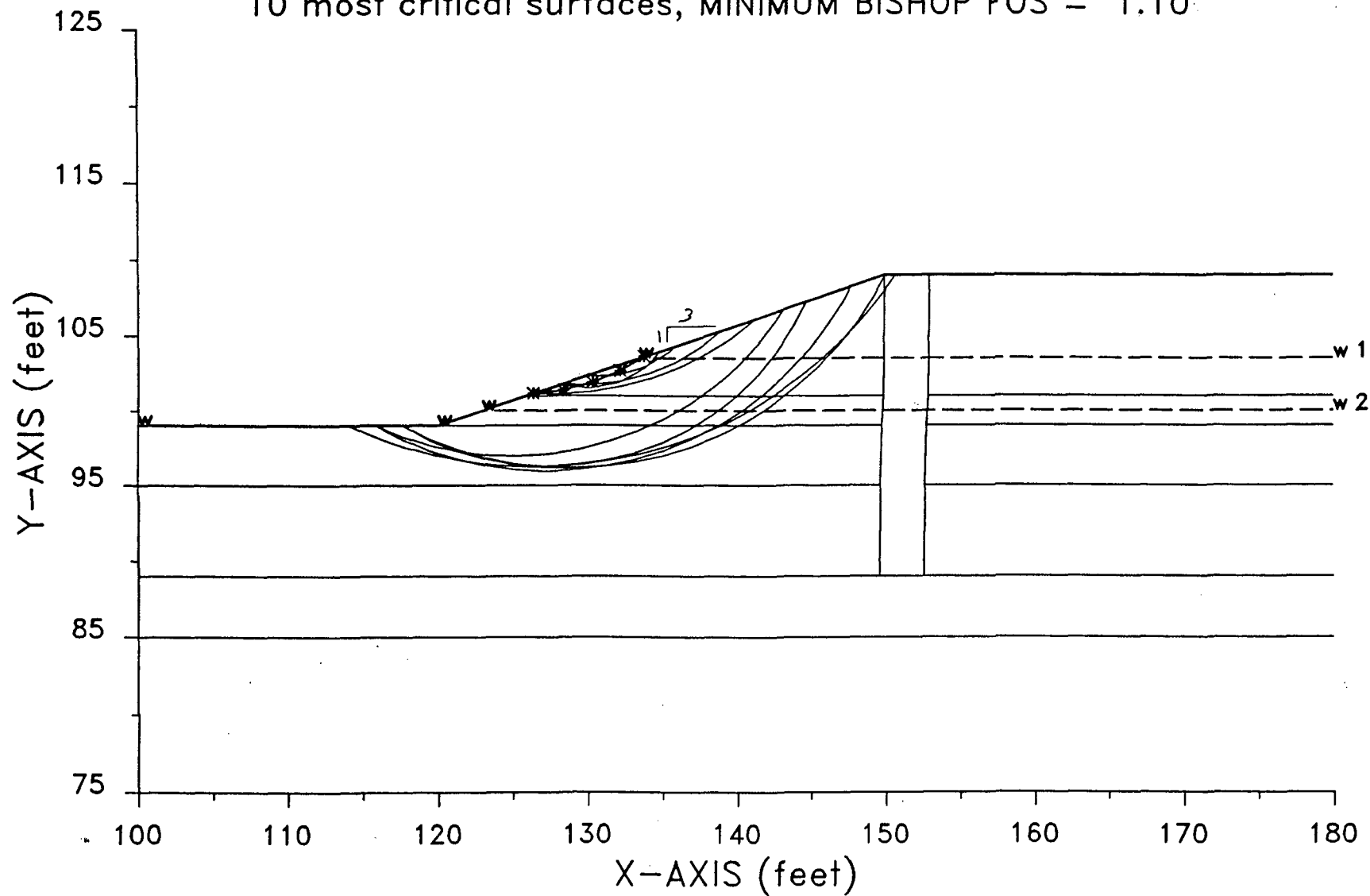
Adjustments to this figure and equation for soils of different compressibility and stress history should be made as described in Section 2.

Attachment B

XSTABL Computer Input and Output

# SHORT TERM STABILITY

10 most critical surfaces, MINIMUM BISHOP FOS = 1.10



PROFIL FILE: CIR3-1SP 2-16-96 14:39 ft

## SHORT TERM STABILITY

23	5				
100.0	99.0	120.0	99.0	3	
120.0	99.0	126.0	101.0	2	
126.0	101.0	150.0	109.0	1	
150.0	109.0	153.0	109.0	7	
153.0	109.0	180.0	109.0	1	
126.0	101.0	149.9	101.0	2	
120.0	99.0	149.8	99.0	3	
100.0	95.0	149.7	95.0	4	
100.0	89.0	149.6	89.0	5	
149.6	89.0	149.7	95.0	7	
149.7	95.0	149.8	99.0	7	
149.8	99.0	149.9	101.0	7	
149.9	101.0	150.0	109.0	7	
149.6	89.0	152.6	89.0	5	
152.6	89.0	152.7	95.0	4	
152.7	95.0	152.8	99.0	3	
152.8	99.0	152.9	101.0	2	
152.9	101.0	153.0	109.0	1	
152.9	101.0	180.0	101.0	2	
152.8	99.0	180.0	99.0	3	
152.7	95.0	180.0	95.0	4	
152.6	89.0	180.0	89.0	5	
100.0	85.0	180.0	85.0	6	

## SOIL

7						
125.0	125.0	.0	35.00	.000	.0	1
100.0	100.0	250.0	.00	.000	.0	2
115.0	115.0	.0	28.00	.000	.0	2
125.0	125.0	1500.0	.00	.000	.0	2
110.0	110.0	350.0	.00	.000	.0	2
125.0	125.0	4000.0	.00	.000	.0	2
95.0	95.0	.0	11.00	.000	.0	2

## WATER

2	62.40		
3			
123.0	100.0		
133.5	103.5		
180.0	103.5		
4			
100.0	99.0		
120.0	99.0		
123.0	100.0		
180.0	100.0		

## CIRCL2

20	20			
100.0	133.5	133.6	180.0	
.0	.0	.0	.0	



XSTABL File: CIR3-1SP 2-16-96 16:49

```

*****
*               X S T A B L               *
*               *                           *
*      Slope Stability Analysis             *
*      using the                           *
*      Method of Slices                    *
*               *                           *
*      Copyright (C) 1992 & 94             *
*      Interactive Software Designs, Inc.   *
*      Moscow, ID 83843, U.S.A.           *
*               *                           *
*      All Rights Reserved                 *
*               *                           *
*      Ver. 5.007a                        94 & 1325 *
*****

```

Problem Description :

SHORT TERM STABILITY

-----  
 SEGMENT BOUNDARY COORDINATES  
 -----

## 5 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	100.0	99.0	120.0	99.0	3
2	120.0	99.0	126.0	101.0	2
3	126.0	101.0	150.0	109.0	1
4	150.0	109.0	153.0	109.0	7
5	153.0	109.0	180.0	109.0	1

## 18 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	126.0	101.0	149.9	101.0	2
2	120.0	99.0	149.8	99.0	3
3	100.0	95.0	149.7	95.0	4
4	100.0	89.0	149.6	89.0	5
5	149.6	89.0	149.7	95.0	7
6	149.7	95.0	149.8	99.0	7
7	149.8	99.0	149.9	101.0	7
8	149.9	101.0	150.0	109.0	7
9	149.6	89.0	152.6	89.0	5
10	152.6	89.0	152.7	95.0	4
11	152.7	95.0	152.8	99.0	3
12	152.8	99.0	152.9	101.0	2
13	152.9	101.0	153.0	109.0	1
14	152.9	101.0	180.0	101.0	2
15	152.8	99.0	180.0	99.0	3
16	152.7	95.0	180.0	95.0	4
17	152.6	89.0	180.0	89.0	5
18	100.0	85.0	180.0	85.0	6

-----  
 ISOTROPIC Soil Parameters  
 -----

## 7 Soil unit(s) specified

Soil Unit No.	Unit Moist (pcf)	Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Constant (psf)	Water Surface No.
1	125.0	125.0	.0	35.00	.000	.0	1
2	100.0	100.0	250.0	.00	.000	.0	2
3	115.0	115.0	.0	28.00	.000	.0	2
4	125.0	125.0	1500.0	.00	.000	.0	2
5	110.0	110.0	350.0	.00	.000	.0	2
6	125.0	125.0	4000.0	.00	.000	.0	2
7	95.0	95.0	.0	11.00	.000	.0	2

## 2 Water surface(s) have been specified

Unit weight of water = 62.40 (pcf)

Water Surface No. 1 specified by 3 coordinate points

\*\*\*\*\*

## PHREATIC SURFACE,

\*\*\*\*\*

Point No.	x-water (ft)	y-water (ft)
1	123.00	100.00
2	133.50	103.50
3	180.00	103.50

Water Surface No. 2 specified by 4 coordinate points

\*\*\*\*\*

## PHREATIC SURFACE,

\*\*\*\*\*

Point No.	x-water (ft)	y-water (ft)
1	100.00	99.00
2	120.00	99.00
3	123.00	100.00
4	180.00	100.00

A critical failure surface searching method, using a random technique for generating CIRCULAR surfaces has been specified.

400 trial surfaces will be generated and analyzed.

20 Surfaces initiate from each of 20 points equally spaced along the ground surface between x = 100.0 ft and x = 133.5 ft

Each surface terminates between x = 133.6 ft and x = 180.0 ft

Unless further limitations were imposed, the minimum elevation at which a surface extends is y = .0 ft

\*\*\*\*\* DEFAULT SEGMENT LENGTH SELECTED BY XSTABL \*\*\*\*\*

2.0 ft line segments define each trial failure surface.

#### ANGULAR RESTRICTIONS :

The first segment of each failure surface will be inclined within the angular range defined by :

Lower angular limit := -45.0 degrees  
Upper angular limit := (slope angle - 5.0) degrees

Factors of safety have been calculated by the :

\*\*\*\*\* SIMPLIFIED BISHOP METHOD \*\*\*\*\*

The most critical circular failure surface is specified by 5 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	126.45	101.15
2	128.43	101.38
3	130.37	101.89
4	132.21	102.66
5	133.83	103.61

\*\*\*\* Simplified BISHOP FOS = 1.100 \*\*\*\*

\*\*\*\*\*  
\*\*  
\*\* Out of the 400 surfaces generated and analyzed by XSTABL, \*\*  
\*\* 3 surfaces were found to have MISLEADING FOS values. \*\*  
\*\*  
\*\*\*\*\*

The following is a summary of the TEN most critical surfaces

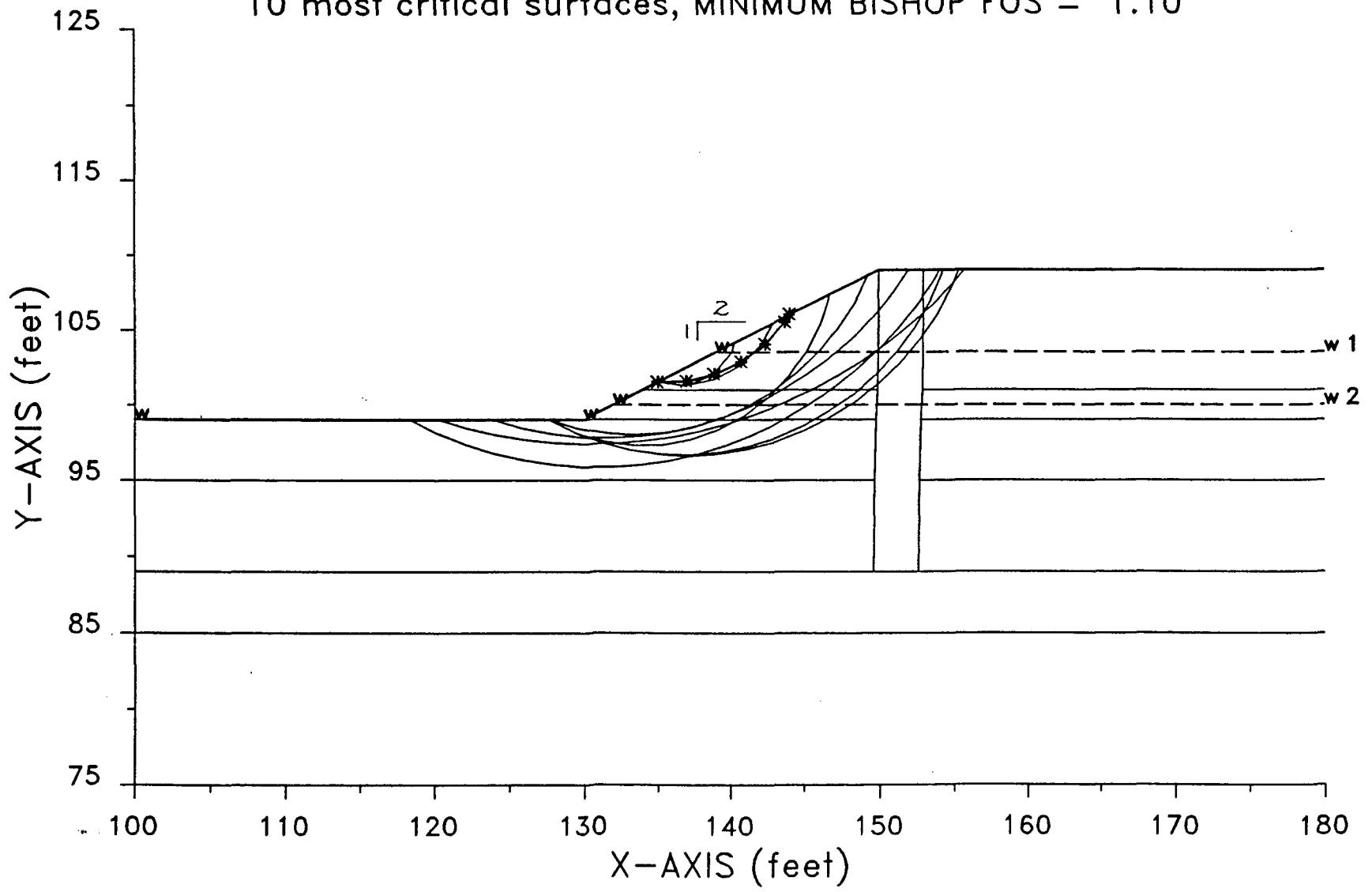
Problem Description :		SHORT TERM STABILITY					
	FOS (BISHOP)	Circle Center x-coord (ft)	Circle Center y-coord (ft)	Radius (ft)	Initial x-coord (ft)	Terminal x-coord (ft)	Resisting Moment (ft-lb)
1.	1.100	125.75	115.59	14.46	126.45	133.83	1.610E+03
2.	1.332	129.97	107.83	6.34	128.21	134.92	1.486E+03
3.	1.380	130.92	109.41	7.15	129.97	135.83	1.009E+03
4.	1.475	129.39	116.28	14.59	128.21	139.02	7.038E+03
5.	1.483	126.52	125.62	29.37	114.11	150.71	2.143E+05
6.	1.489	127.67	122.28	21.17	126.45	141.32	1.861E+04
7.	1.500	127.33	119.10	23.14	115.87	147.73	1.513E+05
8.	1.501	125.06	118.75	21.78	115.87	143.19	8.912E+04

9.	1.512	128.90	120.00	23.83	117.63	150.04	1.755E+05
10.	1.519	127.45	115.42	19.13	117.63	144.75	1.004E+05

\*\*\* END OF FILE \*\*\*

# SHORT TERM STABILITY

10 most critical surfaces, MINIMUM BISHOP FOS = 1.10



PROFIL FILE: CIR2-1SP 2-16-96 15:59 ft

### SHORT TERM STABILITY

23	5			
100.0	99.0	130.0	99.0	3
130.0	99.0	134.0	101.0	2
134.0	101.0	150.0	109.0	1
150.0	109.0	153.0	109.0	7
153.0	109.0	180.0	109.0	1
134.0	101.0	149.9	101.0	2
130.0	99.0	149.8	99.0	3
100.0	95.0	149.7	95.0	4
100.0	89.0	149.6	89.0	5
149.6	89.0	149.7	95.0	7
149.7	95.0	149.8	99.0	7
149.8	99.0	149.9	101.0	7
149.9	101.0	150.0	109.0	7
149.6	89.0	152.6	89.0	5
152.6	89.0	152.7	95.0	4
152.7	95.0	152.8	99.0	3
152.8	99.0	152.9	101.0	2
152.9	101.0	153.0	109.0	1
152.9	101.0	180.0	101.0	2
152.8	99.0	180.0	99.0	3
152.7	95.0	180.0	95.0	4
152.6	89.0	180.0	89.0	5
100.0	85.0	180.0	85.0	6

## SOIL

7						
125.0	125.0	.0	35.00	.000	.0	1
100.0	100.0	250.0	.00	.000	.0	2
115.0	115.0	.0	28.00	.000	.0	2
125.0	125.0	1500.0	.00	.000	.0	2
110.0	110.0	350.0	.00	.000	.0	2
125.0	125.0	4000.0	.00	.000	.0	2
95.0	95.0	.0	11.00	.000	.0	2

**WATER**

2	62.40
---	-------

3	132.0	100.0
	139.0	103.5
	180.0	103.5

4	100.0	99.0
	130.0	99.0
	132.0	100.0
	180.0	100.0

**CIRCL2**

20	20			
100.0	135.0	135.5	180.0	
.0	.0	.0	.0	

XSTABL File: CIR2-1SP 2-16-96 15:59

```

*****
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*               *                           *
*      Slope Stability Analysis             *
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*****

```

Problem Description :                    SHORT TERM STABILITY

-----  
 SEGMENT BOUNDARY COORDINATES  
 -----

5 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	100.0	99.0	130.0	99.0	3
2	130.0	99.0	134.0	101.0	2
3	134.0	101.0	150.0	109.0	1
4	150.0	109.0	153.0	109.0	7
5	153.0	109.0	180.0	109.0	1

18 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	134.0	101.0	149.9	101.0	2
2	130.0	99.0	149.8	99.0	3
3	100.0	95.0	149.7	95.0	4
4	100.0	89.0	149.6	89.0	5
5	149.6	89.0	149.7	95.0	7
6	149.7	95.0	149.8	99.0	7
7	149.8	99.0	149.9	101.0	7
8	149.9	101.0	150.0	109.0	7
9	149.6	89.0	152.6	89.0	5
10	152.6	89.0	152.7	95.0	4
11	152.7	95.0	152.8	99.0	3
12	152.8	99.0	152.9	101.0	2
13	152.9	101.0	153.0	109.0	1
14	152.9	101.0	180.0	101.0	2
15	152.8	99.0	180.0	99.0	3
16	152.7	95.0	180.0	95.0	4
17	152.6	89.0	180.0	89.0	5
18	100.0	85.0	180.0	85.0	6

-----  
 ISOTROPIC Soil Parameters  
 -----

## 7 Soil unit(s) specified

Soil Unit No.	Unit Moist (pcf)	Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pressure Constant (psf)	Water Surface No.
1	125.0	125.0	.0	35.00	.000	.0	1
2	100.0	100.0	250.0	.00	.000	.0	2
3	115.0	115.0	.0	28.00	.000	.0	2
4	125.0	125.0	1500.0	.00	.000	.0	2
5	110.0	110.0	350.0	.00	.000	.0	2
6	125.0	125.0	4000.0	.00	.000	.0	2
7	95.0	95.0	.0	11.00	.000	.0	2

## 2 Water surface(s) have been specified

Unit weight of water = 62.40 (pcf)

Water Surface No. 1 specified by 3 coordinate points

\*\*\*\*\*

## PHREATIC SURFACE,

\*\*\*\*\*

Point No.	x-water (ft)	y-water (ft)
1	132.00	100.00
2	139.00	103.50
3	180.00	103.50

Water Surface No. 2 specified by 4 coordinate points

\*\*\*\*\*

## PHREATIC SURFACE,

\*\*\*\*\*

Point No.	x-water (ft)	y-water (ft)
1	100.00	99.00
2	130.00	99.00
3	132.00	100.00
4	180.00	100.00

A critical failure surface searching method, using a random technique for generating CIRCULAR surfaces has been specified.

400 trial surfaces will be generated and analyzed.

20 Surfaces initiate from each of 20 points equally spaced along the ground surface between x = 100.0 ft and x = 135.0 ft

Each surface terminates between x = 135.5 ft and x = 180.0 ft

Unless further limitations were imposed, the minimum elevation at which a surface extends is y = .0 ft



\*\*\*\*\* DEFAULT SEGMENT LENGTH SELECTED BY XSTABL \*\*\*\*\*

2.0 ft line segments define each trial failure surface.

#### ANGULAR RESTRICTIONS :

The first segment of each failure surface will be inclined within the angular range defined by :

Lower angular limit := -45.0 degrees  
Upper angular limit := (slope angle - 5.0) degrees

Factors of safety have been calculated by the :

\*\*\*\*\* SIMPLIFIED BISHOP METHOD \*\*\*\*\*

The most critical circular failure surface is specified by 7 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	135.00	101.50
2	137.00	101.57
3	138.95	102.03
4	140.76	102.86
5	142.38	104.04
6	143.73	105.51
7	144.04	106.02

\*\*\*\* Simplified BISHOP FOS = 1.106 \*\*\*\*

\*\*\*\*\*  
\*\* Out of the 400 surfaces generated and analyzed by XSTABL, \*\*  
\*\* 10 surfaces were found to have MISLEADING FOS values. \*\*  
\*\*  
\*\*\*\*\*

The following is a summary of the TEN most critical surfaces

#### Problem Description :

#### SHORT TERM STABILITY

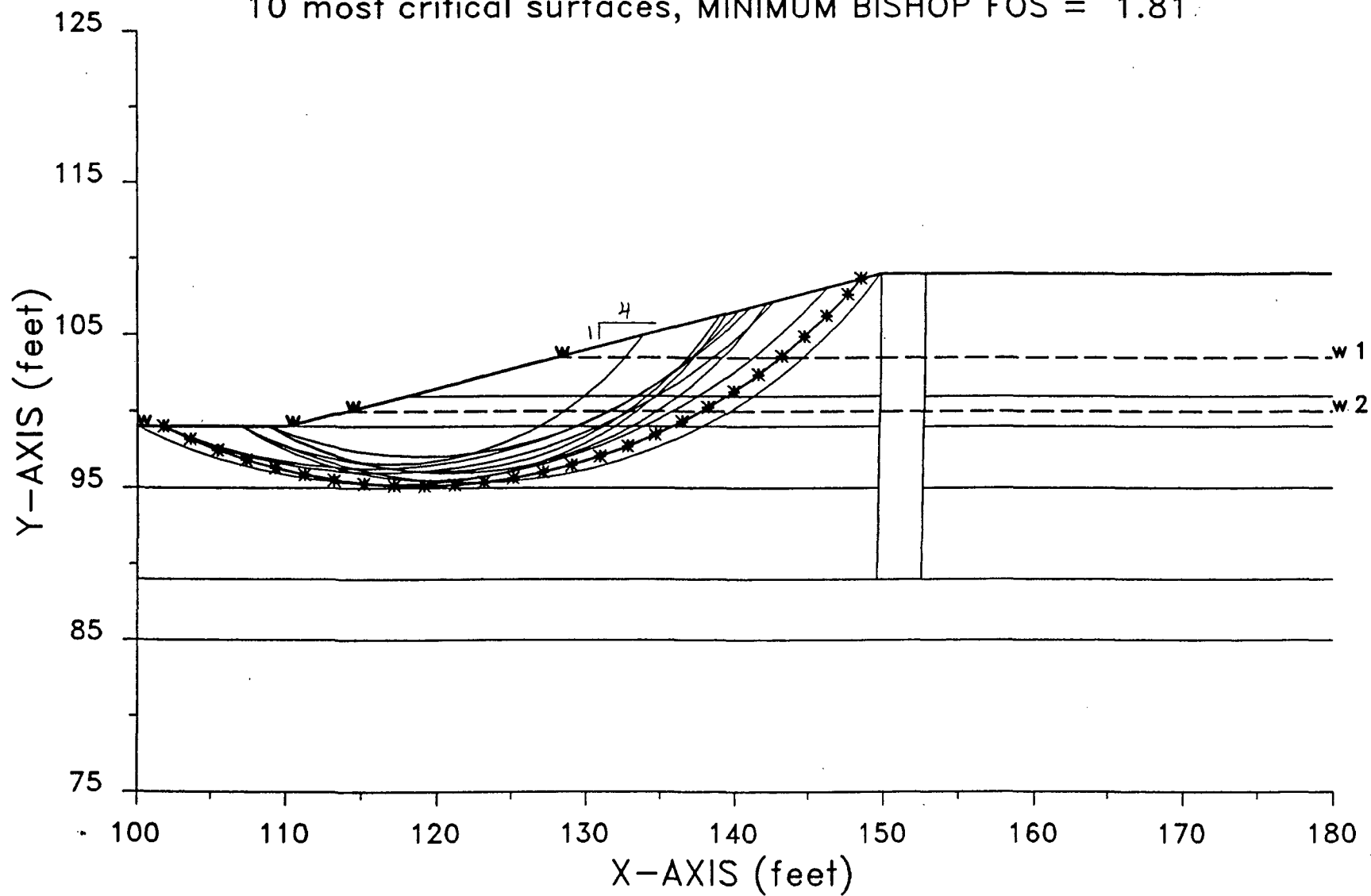
	FOS (BISHOP)	Circle Center x-coord (ft)	Circle Center y-coord (ft)	Radius (ft)	Initial x-coord (ft)	Terminal x-coord (ft)	Resisting Moment (ft-lb)
1.	1.106	135.67	111.56	10.08	135.00	144.04	5.240E+03
2.	1.132	136.47	105.34	4.11	135.00	140.28	1.036E+03
3.	1.151	136.69	108.07	6.78	135.00	142.89	3.560E+03
4.	1.164	136.68	115.51	18.83	127.63	154.34	1.123E+05
5.	1.180	131.51	122.22	24.42	123.95	152.03	1.056E+05
6.	1.182	131.02	122.75	26.88	118.42	154.10	1.696E+05

7.	1.183	137.04	116.43	19.81	127.63	155.39	1.260E+05
8.	1.187	133.38	115.21	17.20	127.63	149.27	6.079E+04
9.	1.190	130.45	130.98	33.56	120.26	155.80	1.831E+05
10.	1.211	134.06	110.35	13.04	127.63	146.75	4.286E+04

\* \* \* END OF FILE \* \* \*

# SHORT TERM STABILITY

10 most critical surfaces, MINIMUM BISHOP FOS = 1.81



101081

## PROFIL

FILE: CIR4-1SP 2-16-96 15:19 ft

## SHORT TERM STABILITY

23	5				
100.0	99.0	110.0	99.0	3	
110.0	99.0	118.0	101.0	2	
118.0	101.0	150.0	109.0	1	
150.0	109.0	153.0	109.0	7	
153.0	109.0	180.0	109.0	1	
118.0	101.0	149.9	101.0	2	
110.0	99.0	149.8	99.0	3	
100.0	95.0	149.7	95.0	4	
100.0	89.0	149.6	89.0	5	
149.6	89.0	149.7	95.0	7	
149.7	95.0	149.8	99.0	7	
149.8	99.0	149.9	101.0	7	
149.9	101.0	150.0	109.0	7	
149.6	89.0	152.6	89.0	5	
152.6	89.0	152.7	95.0	4	
152.7	95.0	152.8	99.0	3	
152.8	99.0	152.9	101.0	2	
152.9	101.0	153.0	109.0	1	
152.9	101.0	180.0	101.0	2	
152.8	99.0	180.0	99.0	3	
152.7	95.0	180.0	95.0	4	
152.6	89.0	180.0	89.0	5	
100.0	85.0	180.0	85.0	6	

## SOIL

7						
125.0	125.0	.0	35.00	.000	.0	1
100.0	100.0	250.0	.00	.000	.0	2
115.0	115.0	.0	28.00	.000	.0	2
125.0	125.0	1500.0	.00	.000	.0	2
110.0	110.0	350.0	.00	.000	.0	2
125.0	125.0	4000.0	.00	.000	.0	2
95.0	95.0	.0	11.00	.000	.0	2

## WATER

2	62.40		
3			
	114.0	100.0	
	128.0	103.5	
	180.0	103.5	
4			
	100.0	99.0	
	110.0	99.0	
	114.0	100.0	
	180.0	100.0	

## CIRCL2

20	20		
100.0	133.5	133.6	180.0
.0	.0	.0	.0

XSTABL File: CIR4-1SP 2-16-96 15:20

```

*****
*               X S T A B L               *
*               *                           *
*      Slope Stability Analysis             *
*      using the                           *
*      Method of Slices                     *
*               *                           *
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*               *                           *
*      Ver. 5.007a                          94 á 1325 *
*****

```

Problem Description :

SHORT TERM STABILITY

-----  
 SEGMENT BOUNDARY COORDINATES  
 -----

## 5 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	100.0	99.0	110.0	99.0	3
2	110.0	99.0	118.0	101.0	2
3	118.0	101.0	150.0	109.0	1
4	150.0	109.0	153.0	109.0	7
5	153.0	109.0	180.0	109.0	1

## 18 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	118.0	101.0	149.9	101.0	2
2	110.0	99.0	149.8	99.0	3
3	100.0	95.0	149.7	95.0	4
4	100.0	89.0	149.6	89.0	5
5	149.6	89.0	149.7	95.0	7
6	149.7	95.0	149.8	99.0	7
7	149.8	99.0	149.9	101.0	7
8	149.9	101.0	150.0	109.0	7
9	149.6	89.0	152.6	89.0	5
10	152.6	89.0	152.7	95.0	4
11	152.7	95.0	152.8	99.0	3
12	152.8	99.0	152.9	101.0	2
13	152.9	101.0	153.0	109.0	1
14	152.9	101.0	180.0	101.0	2
15	152.8	99.0	180.0	99.0	3
16	152.7	95.0	180.0	95.0	4
17	152.6	89.0	180.0	89.0	5
18	100.0	85.0	180.0	85.0	6

-----  
 ISOTROPIC Soil Parameters  
 -----

## 7 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	125.0	125.0	.0	35.00	.000	.0	1
2	100.0	100.0	250.0	.00	.000	.0	2
3	115.0	115.0	.0	28.00	.000	.0	2
4	125.0	125.0	1500.0	.00	.000	.0	2
5	110.0	110.0	350.0	.00	.000	.0	2
6	125.0	125.0	4000.0	.00	.000	.0	2
7	95.0	95.0	.0	11.00	.000	.0	2

## 2 Water surface(s) have been specified

Unit weight of water = 62.40 (pcf)

Water Surface No. 1 specified by 3 coordinate points

\*\*\*\*\*

## PHREATIC SURFACE,

\*\*\*\*\*

Point No.	x-water (ft)	y-water (ft)
1	114.00	100.00
2	128.00	103.50
3	180.00	103.50

Water Surface No. 2 specified by 4 coordinate points

\*\*\*\*\*

## PHREATIC SURFACE,

\*\*\*\*\*

Point No.	x-water (ft)	y-water (ft)
1	100.00	99.00
2	110.00	99.00
3	114.00	100.00
4	180.00	100.00

A critical failure surface searching method, using a random technique for generating CIRCULAR surfaces has been specified.

400 trial surfaces will be generated and analyzed.

20 Surfaces initiate from each of 20 points equally spaced along the ground surface between x = 100.0 ft and x = 133.5 ft

Each surface terminates between x = 133.6 ft and x = 180.0 ft

Unless further limitations were imposed, the minimum elevation at which a surface extends is y = .0 ft

\*\*\*\*\* DEFAULT SEGMENT LENGTH SELECTED BY XSTABL \*\*\*\*\*

2.0 ft line segments define each trial failure surface.

ANGULAR RESTRICTIONS :

The first segment of each failure surface will be inclined  
within the angular range defined by :

Lower angular limit := -45.0 degrees  
Upper angular limit := (slope angle - 5.0) degrees

Factors of safety have been calculated by the :

\*\*\*\*\* SIMPLIFIED BISHOP METHOD \*\*\*\*\*

The most critical circular failure surface  
is specified by 27 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	101.76	99.00
2	103.59	98.19
3	105.46	97.47
4	107.36	96.84
5	109.28	96.31
6	111.24	95.88
7	113.21	95.55
8	115.20	95.32
9	117.19	95.18
10	119.19	95.15
11	121.19	95.22
12	123.18	95.39
13	125.16	95.66
14	127.13	96.03
15	129.07	96.50
16	130.99	97.06
17	132.88	97.73
18	134.73	98.48
19	136.54	99.33
20	138.31	100.27
21	140.03	101.29
22	141.69	102.40
23	143.30	103.60
24	144.84	104.87
25	146.31	106.22
26	147.72	107.64
27	148.63	108.66

\*\*\*\* Simplified BISHOP FOS = 1.817 \*\*\*\*

\*\*\*\*\*  
\*\*  
\*\* Out of the 400 surfaces generated and analyzed by XSTABL, \*\*  
\*\* 4 surfaces were found to have MISLEADING FOS values. \*\*  
\*\*

\*\*\*\*\*

The following is a summary of the TEN most critical surfaces

Problem Description :

SHORT TERM STABILITY

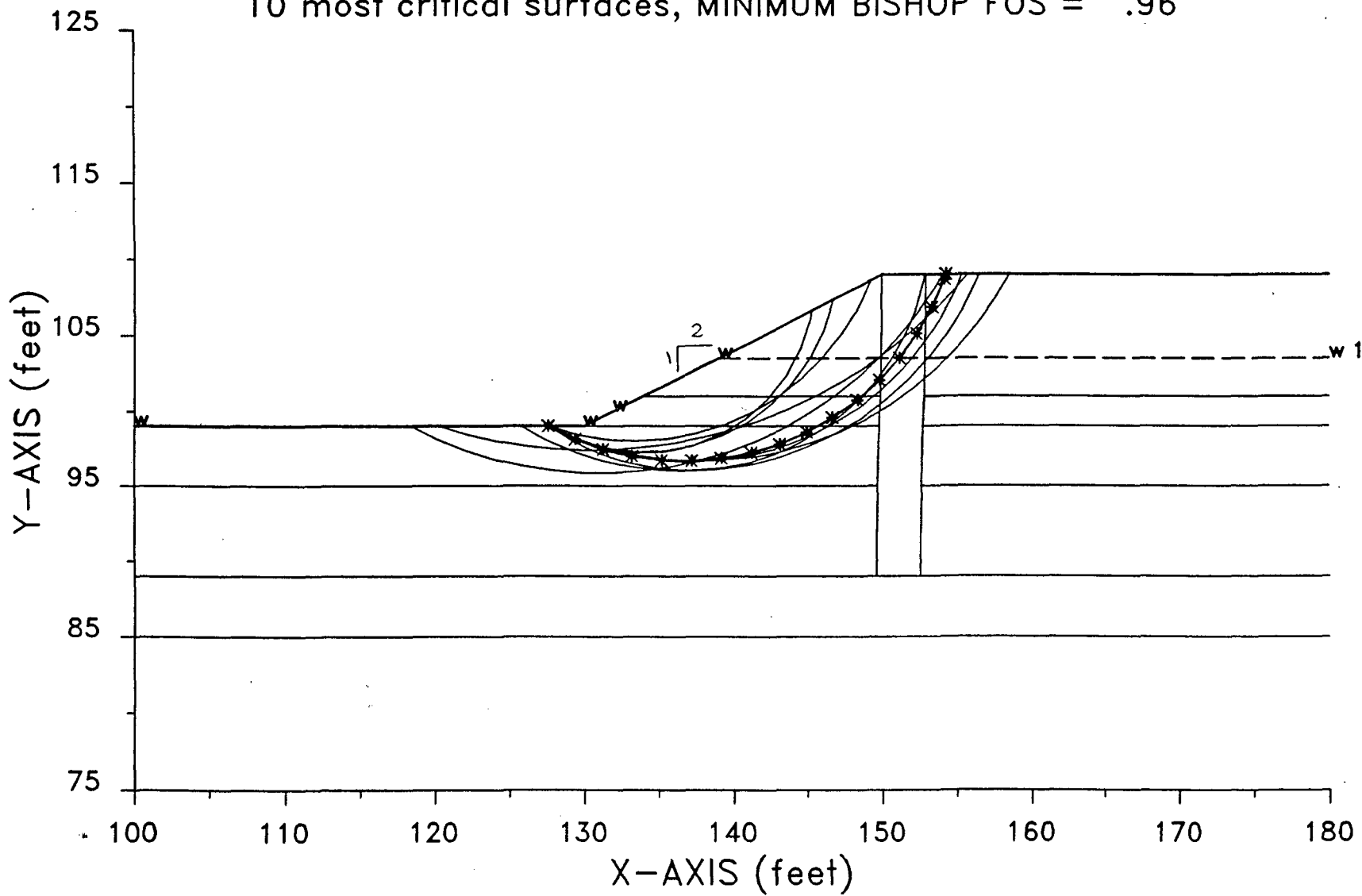
	FOS (BISHOP)	Circle x-coord (ft)	Center y-coord (ft)	Radius (ft)	Initial x-coord (ft)	Terminal x-coord (ft)	Resisting Moment (ft-lb)
1.	1.817	118.81	134.84	39.69	101.76	148.63	3.912E+05
2.	1.824	119.51	119.43	23.93	107.05	139.56	1.502E+05
3.	1.825	122.47	129.89	34.52	107.05	149.94	3.578E+05
4.	1.828	120.98	122.00	26.02	108.82	142.28	1.760E+05
5.	1.829	116.34	132.85	36.85	101.76	142.79	2.465E+05
6.	1.829	119.13	125.54	28.48	108.82	140.37	1.458E+05
7.	1.832	120.03	119.01	22.93	108.82	139.09	1.292E+05
8.	1.836	116.95	135.40	40.15	100.00	146.38	3.533E+05
9.	1.836	116.96	117.96	21.40	107.05	133.98	8.122E+04
10.	1.845	115.57	132.75	36.46	101.76	141.16	2.144E+05

\*\*\* END OF FILE \*\*\*



# SHORT TERM STABILITY

10 most critical surfaces, MINIMUM BISHOP FOS = .96



PROF11 FILE: CIR2-1SH 2-16-96 16:40 ft

## SHORT TERM STABILITY

23 5

100.0	99.0	130.0	99.0	3
130.0	99.0	134.0	101.0	2
134.0	101.0	150.0	109.0	1
150.0	109.0	153.0	109.0	7
153.0	109.0	180.0	109.0	1
134.0	101.0	149.9	101.0	2
130.0	99.0	149.8	99.0	3
100.0	95.0	149.7	95.0	4
100.0	89.0	149.6	89.0	5
149.6	89.0	149.7	95.0	7
149.7	95.0	149.8	99.0	7
149.8	99.0	149.9	101.0	7
149.9	101.0	150.0	109.0	7
149.6	89.0	152.6	89.0	5
152.6	89.0	152.7	95.0	4
152.7	95.0	152.8	99.0	3
152.8	99.0	152.9	101.0	2
152.9	101.0	153.0	109.0	1
152.9	101.0	180.0	101.0	2
152.8	99.0	180.0	99.0	3
152.7	95.0	180.0	95.0	4
152.6	89.0	180.0	89.0	5
100.0	85.0	180.0	85.0	6

## SOIL

7

125.0	125.0	.0	35.00	.000	.0	1
100.0	100.0	250.0	.00	.000	.0	1
115.0	115.0	.0	28.00	.000	.0	1
125.0	125.0	1500.0	.00	.000	.0	1
110.0	110.0	350.0	.00	.000	.0	1
125.0	125.0	4000.0	.00	.000	.0	1
95.0	95.0	.0	11.00	.000	.0	1

## WATER

1 62.40

5

100.0	99.0
130.0	99.0
132.0	100.0
139.0	103.5
180.0	103.5

## CIRCL2

20 20

100.0	135.0	135.5	180.0
.0	.0	.0	.0

XSTABL File: CIR2-1SH 2-16-96 16:46

```

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*****

```

Problem Description : SHORT TERM STABILITY

-----  
 SEGMENT BOUNDARY COORDINATES  
 -----

## 5 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	100.0	99.0	130.0	99.0	3
2	130.0	99.0	134.0	101.0	2
3	134.0	101.0	150.0	109.0	1
4	150.0	109.0	153.0	109.0	7
5	153.0	109.0	180.0	109.0	1

## 18 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	134.0	101.0	149.9	101.0	2
2	130.0	99.0	149.8	99.0	3
3	100.0	95.0	149.7	95.0	4
4	100.0	89.0	149.6	89.0	5
5	149.6	89.0	149.7	95.0	7
6	149.7	95.0	149.8	99.0	7
7	149.8	99.0	149.9	101.0	7
8	149.9	101.0	150.0	109.0	7
9	149.6	89.0	152.6	89.0	5
10	152.6	89.0	152.7	95.0	4
11	152.7	95.0	152.8	99.0	3
12	152.8	99.0	152.9	101.0	2
13	152.9	101.0	153.0	109.0	1
14	152.9	101.0	180.0	101.0	2
15	152.8	99.0	180.0	99.0	3
16	152.7	95.0	180.0	95.0	4
17	152.6	89.0	180.0	89.0	5
18	100.0	85.0	180.0	85.0	6

-----  
 ISOTROPIC Soil Parameters  
 -----

## 7 Soil unit(s) specified

Soil Unit No.	Unit Moist (pcf)	Unit Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	125.0	125.0	.0	35.00	.000	.0	1
2	100.0	100.0	250.0	.00	.000	.0	1
3	115.0	115.0	.0	28.00	.000	.0	1
4	125.0	125.0	1500.0	.00	.000	.0	1
5	110.0	110.0	350.0	.00	.000	.0	1
6	125.0	125.0	4000.0	.00	.000	.0	1
7	95.0	95.0	.0	11.00	.000	.0	1

## 1 Water surface(s) have been specified

Unit weight of water = 62.40 (pcf)

Water Surface No. 1 specified by 5 coordinate points

\*\*\*\*\*

## PHREATIC SURFACE;

\*\*\*\*\*

Point No.	x-water (ft)	y-water (ft)
1	100.00	99.00
2	130.00	99.00
3	132.00	100.00
4	139.00	103.50
5	180.00	103.50

A critical failure surface searching method, using a random technique for generating CIRCULAR surfaces has been specified.

400 trial surfaces will be generated and analyzed.

20 Surfaces initiate from each of 20 points equally spaced along the ground surface between x = 100.0 ft and x = 135.0 ft

Each surface terminates between x = 135.5 ft and x = 180.0 ft

Unless further limitations were imposed, the minimum elevation at which a surface extends is y = .0 ft

\*\*\*\*\* DEFAULT SEGMENT LENGTH SELECTED BY XSTABL \*\*\*\*\*

2.0 ft line segments define each trial failure surface.

## ANGULAR RESTRICTIONS :

The first segment of each failure surface will be inclined within the angular range defined by :

Lower angular limit := -45.0 degrees  
 Upper angular limit := (slope angle - 5.0) degrees

Factors of safety have been calculated by the :

\*\*\*\*\* SIMPLIFIED BISHOP METHOD \*\*\*\*\*

The most critical circular failure surface  
 is specified by 18 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	127.63	99.00
2	129.43	98.13
3	131.32	97.46
4	133.26	96.99
5	135.25	96.74
6	137.25	96.69
7	139.24	96.85
8	141.20	97.23
9	143.12	97.81
10	144.96	98.59
11	146.70	99.57
12	148.34	100.72
13	149.84	102.04
14	151.20	103.51
15	152.39	105.12
16	153.40	106.84
17	154.23	108.66
18	154.34	109.00

\*\*\*\* Simplified BISHOP FOS = .968 \*\*\*\*

\*\*\*\*\*  
 \*\* Out of the 400 surfaces generated and analyzed by XSTABL, \*\*  
 \*\* 9 surfaces were found to have MISLEADING FOS values. \*\*  
 \*\*  
 \*\*\*\*\*

The following is a summary of the TEN most critical surfaces

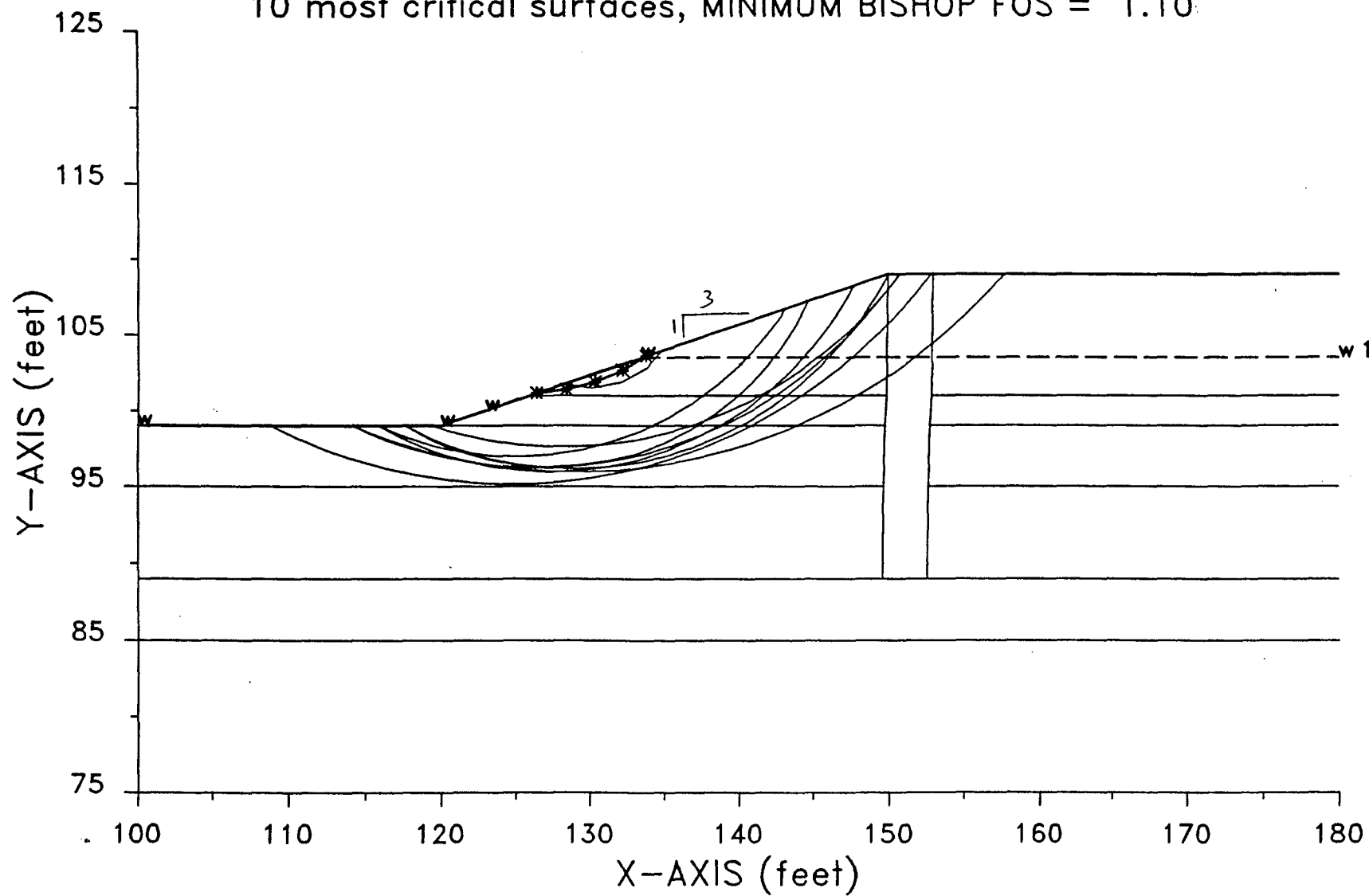
Problem Description :		SHORT TERM STABILITY					
FOS (BISHOP)	Circle Center x-coord y-coord (ft) (ft)	Radius (ft)	Initial x-coord (ft)	Terminal x-coord (ft)	Resisting Moment (ft-lb)		
1.	.968	136.68	115.51	18.83	127.63	154.34	9.335E+04
2.	.976	137.04	116.43	19.81	127.63	155.39	1.039E+05
3.	1.016	136.98	112.42	16.35	127.63	152.96	8.495E+04
4.	1.019	136.77	117.59	21.59	125.79	156.56	1.327E+05
5.	1.049	131.02	122.75	26.88	118.42	154.10	1.504E+05
6.	1.061	134.06	110.35	13.04	127.63	146.75	3.756E+04
7.	1.083	137.82	120.34	23.65	127.63	158.56	1.526E+05
8.	1.091	133.38	115.21	17.20	127.63	149.27	5.589E+04

9.	1.095	130.45	130.98	33.56	120.26	155.80	1.684E+05
10.	1.096	133.87	108.87	11.67	127.63	145.29	3.022E+04

\* \* \* END OF FILE \* \* \*

# SHORT TERM STABILITY

10 most critical surfaces, MINIMUM BISHOP FOS = 1.10



101093

PROFIL FILE: CIR3-1SH 2-16-96 16:19 ft

## SHORT TERM STABILITY

23	5				
100.0	99.0	120.0	99.0	3	
120.0	99.0	126.0	101.0	2	
126.0	101.0	150.0	109.0	1	
150.0	109.0	153.0	109.0	7	
153.0	109.0	180.0	109.0	1	
126.0	101.0	149.9	101.0	2	
120.0	99.0	149.8	99.0	3	
100.0	95.0	149.7	95.0	4	
100.0	89.0	149.6	89.0	5	
149.6	89.0	149.7	95.0	7	
149.7	95.0	149.8	99.0	7	
149.8	99.0	149.9	101.0	7	
149.9	101.0	150.0	109.0	7	
149.6	89.0	152.6	89.0	5	
152.6	89.0	152.7	95.0	4	
152.7	95.0	152.8	99.0	3	
152.8	99.0	152.9	101.0	2	
152.9	101.0	153.0	109.0	1	
152.9	101.0	180.0	101.0	2	
152.8	99.0	180.0	99.0	3	
152.7	95.0	180.0	95.0	4	
152.6	89.0	180.0	89.0	5	
100.0	85.0	180.0	85.0	6	

## SOIL

7						
125.0	125.0	.0	35.00	.000	.0	1
100.0	100.0	250.0	.00	.000	.0	1
115.0	115.0	.0	28.00	.000	.0	1
125.0	125.0	1500.0	.00	.000	.0	1
110.0	110.0	350.0	.00	.000	.0	1
125.0	125.0	4000.0	.00	.000	.0	1
95.0	95.0	.0	11.00	.000	.0	1

## WATER

1 62.40  
5

100.0	99.0
120.0	99.0
123.0	100.0
133.5	103.5
180.0	103.5

## CIRCL2

20	20			
100.0	133.5	133.6	180.0	
.0	.0	.0	.0	



XSTABL File: CIR3-1SH 2-16-96 16:19

```

*****
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*      Ver. 5.007a                         94 & 1325 *
*****

```

Problem Description : PSEC/FRI-IRA/NY SHORT TERM STABILITY

-----  
 SEGMENT BOUNDARY COORDINATES  
 -----

## 5 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	100.0	99.0	120.0	99.0	3
2	120.0	99.0	126.0	101.0	2
3	126.0	101.0	150.0	109.0	1
4	150.0	109.0	153.0	109.0	7
5	153.0	109.0	180.0	109.0	1

## 18 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	126.0	101.0	149.9	101.0	2
2	120.0	99.0	149.8	99.0	3
3	100.0	95.0	149.7	95.0	4
4	100.0	89.0	149.6	89.0	5
5	149.6	89.0	149.7	95.0	7
6	149.7	95.0	149.8	99.0	7
7	149.8	99.0	149.9	101.0	7
8	149.9	101.0	150.0	109.0	7
9	149.6	89.0	152.6	89.0	5
10	152.6	89.0	152.7	95.0	4
11	152.7	95.0	152.8	99.0	3
12	152.8	99.0	152.9	101.0	2
13	152.9	101.0	153.0	109.0	1
14	152.9	101.0	180.0	101.0	2
15	152.8	99.0	180.0	99.0	3
16	152.7	95.0	180.0	95.0	4
17	152.6	89.0	180.0	89.0	5
18	100.0	85.0	180.0	85.0	6

-----  
 ISOTROPIC Soil Parameters  
 -----

## 7 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	125.0	125.0	.0	35.00	.000	.0	1
2	100.0	100.0	250.0	.00	.000	.0	1
3	115.0	115.0	.0	28.00	.000	.0	1
4	125.0	125.0	1500.0	.00	.000	.0	1
5	110.0	110.0	350.0	.00	.000	.0	1
6	125.0	125.0	4000.0	.00	.000	.0	1
7	95.0	95.0	.0	11.00	.000	.0	1

## 1 Water surface(s) have been specified

Unit weight of water = 62.40 (pcf)

Water Surface No. 1 specified by 5 coordinate points

\*\*\*\*\*

## PHREATIC SURFACE,

\*\*\*\*\*

Point No.	x-water (ft)	y-water (ft)
1	100.00	99.00
2	120.00	99.00
3	123.00	100.00
4	133.50	103.50
5	180.00	103.50

A critical failure surface searching method, using a random technique for generating CIRCULAR surfaces has been specified.

400 trial surfaces will be generated and analyzed.

20 Surfaces initiate from each of 20 points equally spaced along the ground surface between x = 100.0 ft and x = 133.5 ft

Each surface terminates between x = 133.6 ft and x = 180.0 ft

Unless further limitations were imposed, the minimum elevation at which a surface extends is y = .0 ft

\*\*\*\*\* DEFAULT SEGMENT LENGTH SELECTED BY XSTABL \*\*\*\*\*

2.0 ft line segments define each trial failure surface.

## ANGULAR RESTRICTIONS :

The first segment of each failure surface will be inclined within the angular range defined by :

Lower angular limit := -45.0 degrees  
 Upper angular limit := (slope angle - 5.0) degrees

\*\*\*\*\*  
 -- WARNING -- WARNING -- WARNING -- WARNING -- (# 48)

Factors of safety have been calculated by the :

\* \* \* \* \* SIMPLIFIED BISHOP METHOD \* \* \* \* \*

The most critical circular failure surface  
 is specified by 5 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	126.45	101.15
2	128.43	101.38
3	130.37	101.89
4	132.21	102.66
5	133.83	103.61

\*\*\*\* Simplified BISHOP FOS = 1.100 \*\*\*\*

\*\*\*\*\*  
 \*\*  
 \*\* Out of the 400 surfaces generated and analyzed by XSTABL, \*\*  
 \*\* 3 surfaces were found to have MISLEADING FOS values. \*\*  
 \*\*  
 \*\*\*\*\*

The following is a summary of the TEN most critical surfaces

Problem Description :

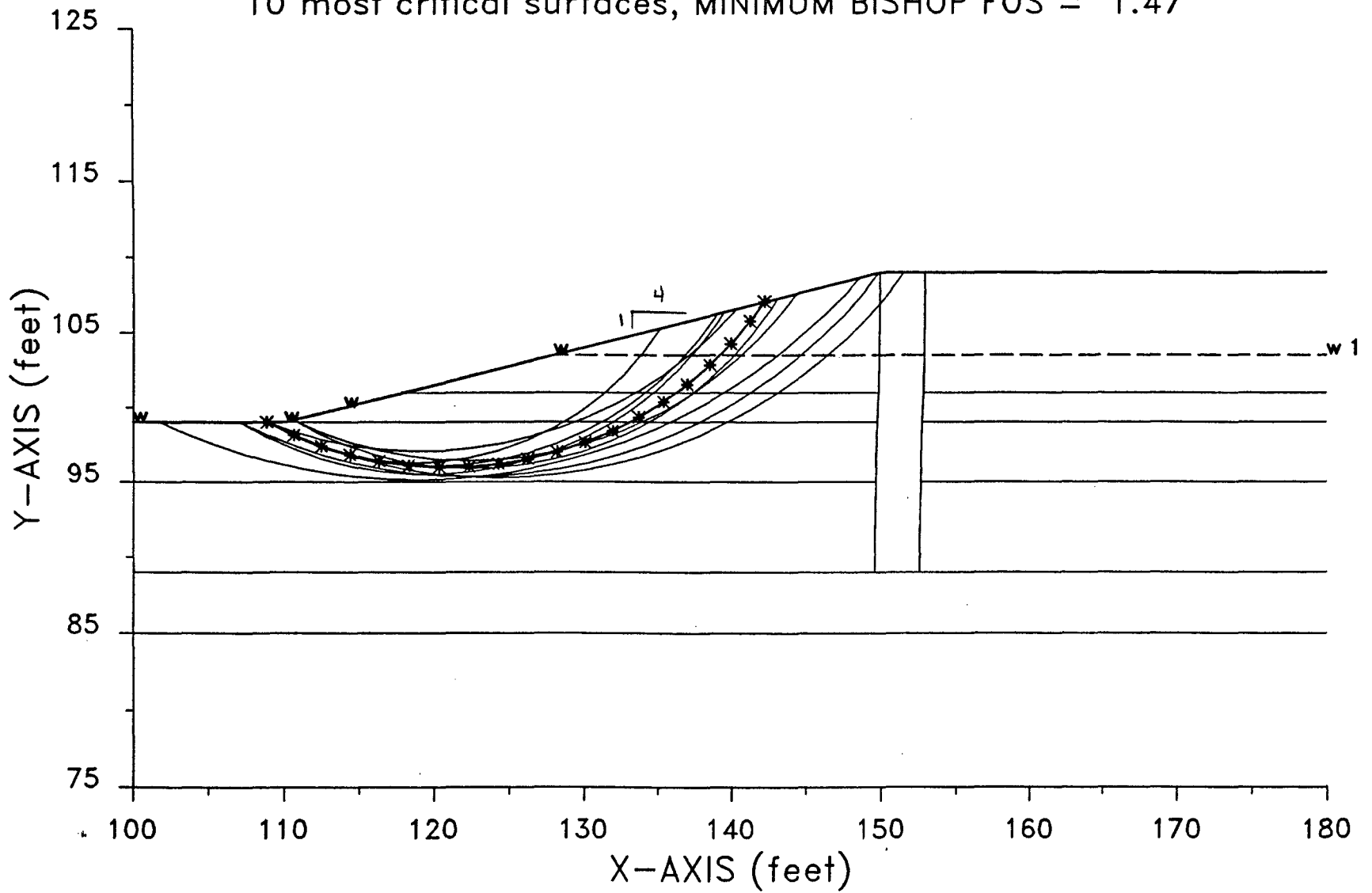
SHORT TERM STABILITY

	FOS (BISHOP)	Circle Center x-coord y-coord (ft) (ft)	Radius (ft)	Initial x-coord (ft)	Terminal x-coord (ft)	Resisting Moment (ft-lb)
1.	1.100	125.75 115.59	14.46	126.45	133.83	1.610E+03
2.	1.246	128.90 120.00	23.83	117.63	150.04	1.447E+05
3.	1.248	127.33 119.10	23.14	115.87	147.73	1.259E+05
4.	1.254	126.52 125.62	29.37	114.11	150.71	1.811E+05
5.	1.255	127.45 115.42	19.13	117.63	144.75	8.292E+04
6.	1.268	129.02 134.16	38.19	114.11	157.76	3.177E+05
7.	1.293	128.13 125.89	28.27	119.39	150.77	1.490E+05
8.	1.294	125.06 118.75	21.78	115.87	143.19	7.684E+04
9.	1.304	124.83 130.55	35.38	108.82	152.88	2.778E+05
10.	1.332	129.97 107.83	6.34	128.21	134.92	1.486E+03

\* \* \* END OF FILE \* \* \*

# SHORT TERM STABILITY

10 most critical surfaces, MINIMUM BISHOP FOS = 1.47



## PROF11

FILE: CIR4-1SH 2-16-96 16:21 ft

## SHORT TERM STABILITY

23	5				
100.0	99.0	110.0	99.0	3	
110.0	99.0	118.0	101.0	2	
118.0	101.0	150.0	109.0	1	
150.0	109.0	153.0	109.0	7	
153.0	109.0	180.0	109.0	1	
118.0	101.0	149.9	101.0	2	
110.0	99.0	149.8	99.0	3	
100.0	95.0	149.7	95.0	4	
100.0	89.0	149.6	89.0	5	
149.6	89.0	149.7	95.0	7	
149.7	95.0	149.8	99.0	7	
149.8	99.0	149.9	101.0	7	
149.9	101.0	150.0	109.0	7	
149.6	89.0	152.6	89.0	5	
152.6	89.0	152.7	95.0	4	
152.7	95.0	152.8	99.0	3	
152.8	99.0	152.9	101.0	2	
152.9	101.0	153.0	109.0	1	
152.9	101.0	180.0	101.0	2	
152.8	99.0	180.0	99.0	3	
152.7	95.0	180.0	95.0	4	
152.6	89.0	180.0	89.0	5	
100.0	85.0	180.0	85.0	6	

## SOIL

7						
125.0	125.0	.0	35.00	.000	.0	1
100.0	100.0	250.0	.00	.000	.0	1
115.0	115.0	.0	28.00	.000	.0	1
125.0	125.0	1500.0	.00	.000	.0	1
110.0	110.0	350.0	.00	.000	.0	1
125.0	125.0	4000.0	.00	.000	.0	1
95.0	95.0	.0	11.00	.000	.0	1

## WATER

1	5	62.40
100.0	99.0	
110.0	99.0	
114.0	100.0	
128.0	103.5	
180.0	103.5	

## CIRCL2

20	20			
100.0	133.5	133.6	180.0	
.0	.0	.0	.0	

XSTABL File: CIR4-1SH 2-16-96 16:21

```

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*               Ver. 5.007a                 *
*               94 á 1325                   *
*****

```

Problem Description : PSEC/FRI-IRA/NY SHORT TERM STABILITY

-----  
 SEGMENT BOUNDARY COORDINATES  
 -----

## 5 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	100.0	99.0	110.0	99.0	3
2	110.0	99.0	118.0	101.0	2
3	118.0	101.0	150.0	109.0	1
4	150.0	109.0	153.0	109.0	7
5	153.0	109.0	180.0	109.0	1

## 18 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	118.0	101.0	149.9	101.0	2
2	110.0	99.0	149.8	99.0	3
3	100.0	95.0	149.7	95.0	4
4	100.0	89.0	149.6	89.0	5
5	149.6	89.0	149.7	95.0	7
6	149.7	95.0	149.8	99.0	7
7	149.8	99.0	149.9	101.0	7
8	149.9	101.0	150.0	109.0	7
9	149.6	89.0	152.6	89.0	5
10	152.6	89.0	152.7	95.0	4
11	152.7	95.0	152.8	99.0	3
12	152.8	99.0	152.9	101.0	2
13	152.9	101.0	153.0	109.0	1
14	152.9	101.0	180.0	101.0	2
15	152.8	99.0	180.0	99.0	3
16	152.7	95.0	180.0	95.0	4
17	152.6	89.0	180.0	89.0	5
18	100.0	85.0	180.0	85.0	6

-----  
 ISOTROPIC Soil Parameters  
 -----

## 7 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pressure Constant (psf)	Water Surface No.
1	125.0	125.0	.0	35.00	.000	.0	1
2	100.0	100.0	250.0	.00	.000	.0	1
3	115.0	115.0	.0	28.00	.000	.0	1
4	125.0	125.0	1500.0	.00	.000	.0	1
5	110.0	110.0	350.0	.00	.000	.0	1
6	125.0	125.0	4000.0	.00	.000	.0	1
7	95.0	95.0	.0	11.00	.000	.0	1

## 1 Water surface(s) have been specified

Unit weight of water = 62.40 (pcf)

Water Surface No. 1 specified by 5 coordinate points

\*\*\*\*\*  
PHREATIC SURFACE,  
\*\*\*\*\*

Point No.	x-water (ft)	y-water (ft)
1	100.00	99.00
2	110.00	99.00
3	114.00	100.00
4	128.00	103.50
5	180.00	103.50

A critical failure surface searching method, using a random technique for generating CIRCULAR surfaces has been specified.

400 trial surfaces will be generated and analyzed.

20 Surfaces initiate from each of 20 points equally spaced along the ground surface between x = 100.0 ft and x = 133.5 ft

Each surface terminates between x = 133.6 ft and x = 180.0 ft

Unless further limitations were imposed, the minimum elevation at which a surface extends is y = .0 ft

\*\*\*\*\* DEFAULT SEGMENT LENGTH SELECTED BY XSTABL \*\*\*\*\*

2.0 ft line segments define each trial failure surface.

## ANGULAR RESTRICTIONS :

The first segment of each failure surface will be inclined within the angular range defined by :

Lower angular limit := -45.0 degrees  
 Upper angular limit := (slope angle - 5.0) degrees

Factors of safety have been calculated by the :

\*\*\*\*\* SIMPLIFIED BISHOP METHOD \*\*\*\*\*

The most critical circular failure surface  
 is specified by 20 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	108.82	99.00
2	110.62	98.13
3	112.48	97.41
4	114.40	96.83
5	116.35	96.40
6	118.33	96.12
7	120.33	95.99
8	122.33	96.02
9	124.32	96.20
10	126.29	96.53
11	128.23	97.01
12	130.13	97.64
13	131.97	98.42
14	133.75	99.33
15	135.45	100.38
16	137.07	101.55
17	138.60	102.85
18	140.01	104.26
19	141.32	105.77
20	142.28	107.07

\*\*\*\* Simplified BISHOP FOS = 1.471 \*\*\*\*

\*\*\*\*\*  
 \*\* Out of the 400 surfaces generated and analyzed by XSTABL, \*\*  
 \*\* 4 surfaces were found to have MISLEADING FOS values. \*\*  
 \*\*  
 \*\*\*\*\*

The following is a summary of the TEN most critical surfaces

Problem Description :

SHORT TERM STABILITY

	FOS (BISHOP)	Circle Center x-coord (ft)	y-coord (ft)	Radius (ft)	Initial x-coord (ft)	Terminal x-coord (ft)	Resisting Moment (ft-lb)
1.	1.471	120.98	122.00	26.02	108.82	142.28	1.417E+05
2.	1.480	120.03	119.01	22.93	108.82	139.09	1.044E+05
3.	1.488	119.51	119.43	23.93	107.05	139.56	1.225E+05
4.	1.490	122.47	129.89	34.52	107.05	149.94	2.920E+05
5.	1.507	124.30	129.41	34.12	108.82	151.63	3.146E+05
6.	1.510	119.13	125.54	28.48	108.82	140.37	1.204E+05



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7.	1.515	122.43	123.75	27.31	110.58	144.45	1.584E+05
8.	1.517	118.81	134.84	39.69	101.76	148.63	3.268E+05
9.	1.520	118.75	115.83	19.54	108.82	135.21	6.966E+04
10.	1.522	122.66	120.09	24.18	110.58	143.14	1.414E+05

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## APPENDIX C

### Sampling, Analysis and Monitoring Plan

APPENDIX C

SAMPLING, ANALYSIS AND MONITORING PLAN  
FOR FOCUSED FEASIBILITY STUDY INVESTIGATION  
216 PATERSON PLANK ROAD SITE  
CARLSTADT, NEW JERSEY

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## 1.0 INTRODUCTION

This Sampling, Analysis, and Monitoring Plan (SAMP) has been prepared as part of the Focused Feasibility Study Investigation Work Plan (FFSI Work Plan) for the 216 Paterson Plank Road Site (Site) in Carlstadt, Bergen County, New Jersey. The purpose of this SAMP is to provide additional detail for the investigation and sampling and analysis procedures described in Sections 4.0 and 5.0 of the FFSI Work Plan.

The general activities which comprise the FFS investigation are as follows:

1. Geophysical Surveys: focused in the areas of boring location B-1 and the two former pond areas;
2. Soil Boring Program: to define characteristics (areal extent, subsurface material types, and chemical constituent concentrations) within the potential "hot-spot" area at location B-1 and, based on the geophysical survey results, similar locations within the two former pond areas;
3. Geotechnical Sample Collection and Analyses: to provide geotechnical data for the meadow mat layer and upper glaciolacustrine varved unit below the potential "hot-spot" area; and,
4. Other field procedures required to completed the items above (e.g., decontamination).

The rationale, objectives, and general technical scope of work for these activities is presented in the FFSI Work Plan. The remainder of this SAMP contains detailed procedural information regarding the geophysical survey, drilling, sample collection, and decontamination procedures. The locations of the proposed soil borings are shown on Figure C1 and a summary of the investigation is provided in Table C1.

---

## **2.0 DETAILED SITE INVESTIGATION PROCEDURES**

### **2.1 Decontamination and Waste Handling**

Before initiating any drilling activities the drill rig, drilling tools, and sampling equipment will be decontaminated as described in Section 3.0 of this SAMP. An on-site decontamination pad will be constructed at the approximate location shown on Figure C1. Solids will be separated and stored in D.O.T. approved 55-gallon drums and staged on-Site for subsequent disposal as Investigation Derived Waste (IDW). Aqueous liquids will be collected and pumped into the existing on-Site 10,000-gallon holding tank. Potable water from a local municipal water supply will be used for all drilling activities (e.g. steam cleaning, decontamination) unless an alternative water source is approved by the USEPA. For soil borings that do not compromise the silt layer underlying the meadow mat, drill cuttings will be placed back into each borehole and, if necessary, the borehole will be completed with a granular bentonite grout to the ground surface. Soil borings that compromise the silt layer will be backfilled with granular bentonite a minimum of 2 feet above the top of the silt and soil borings that extend into the varved clay unit, in order to obtain a sample, will be tremie grouted to a minimum of 2 feet above the sample location. Drill cuttings will then be placed in the borehole with inert fill if necessary. All grouting mixtures will be in accordance with the NJDEP Field Sampling Procedures Manual (May 1992).

### **2.2 Geophysical Survey**

Two geophysical techniques will be employed to assist in the characterization of the B-1 and former pond areas as shown on Figure C1: frequency domain electromagnetic (FEM) and ground penetrating radar (GPR). The geophysical survey technical procedures for the EM-31 and GPR instruments are described in detail in Attachment C1.

### **2.3 Borehole Drilling Procedures**

Boreholes will be drilled by a New Jersey licensed well driller, and supervised by a geologist or engineer qualified by education and experience. Because the anticipated depth of each boring is less than 25 feet, a Well Drilling Permit will not be required. Soil samples will be examined by the supervising field geologist or engineer who will maintain a descriptive log for each boring. Additionally, the supervising field geologist or engineer will document sampling activities.

Each borehole will be completed using hollow-stem auger drilling techniques. To protect the geomembrane (infiltration barrier), an all terrain vehicle (ATV) with rubber mounted tires or similar equipment will be used. Additionally, a protective covering (e.g. plywood) will be placed on top of the geomembrane in front of the drill rig as it advances to each boring location and beneath each of the rig set hydraulic jacks. Access to the soil boring location will also require careful maneuvering around the above ground piping, or, if necessary, placing a ramp over the piping or temporarily removing the lines. The USEPA will be immediately notified of any impact or damage to the dewatering system. If any repairs to the dewatering are necessary, the USEPA will be notified prior to commencing the work.

A minimum area of geomembrane will be cut and removed in order to advance the drill bit and rods. Following completion of the boring, the exposed area will be temporarily covered with plastic, secured with sandbags or wood. Upon completion of the investigation, the geomembrane will be repaired by an approved geosynthetic installer in accordance with Section 4.2 of the Operation and Maintenance Plan (Canonie Environmental, July 19, 1991).

A soil boring will be completed at the estimated locations of B-1 to verify the existence sludge-like material. A total of four soil borings (GB-01 through GB-04) are proposed for the potential "hot spot" B-1 area investigation of which two will be used to collect a Shelby tube sample of the meadow mat and glaciolacustrine varved unit. The extent of the boring investigation for the former pond areas will be determined based on the results of the geophysical survey and boring investigation for the B-1 area. Proposed approximate drilling locations are shown on Figure C1.

#### ***B-1 and Pond Area Investigation***

Borings will be drilled principally using 4.25-inch inside diameter (ID) hollow-stem augers (HSA). Subsurface samples will be collected (in general conformance with ASTM D-1586) by driving a 3-inch outside diameter (OD) split-spoon sampler, a distance of 2 feet ahead of the boring into undisturbed fill material at continuous intervals to the top of natural soil. Blow counts required to drive the split-spoon each 3-inch increment will be recorded. The total recovery of the samples will be measured and soils will be classified using the Unified Soils Classification System (USCS) based on visual description only. In addition, general auger resistance will be qualitatively described (e.g., advancement rate, rig chatter) to provide additional information on the subsurface conditions. If possible, the drilling torque will be monitored from the drill rig instrumentation.

Samples collected from the borings will be characterized by visual observation and field monitoring for the potential presence of volatile organic compounds (VOCs) using a PID and/or FID. Readings will be recorded on the borehole log and daily field logs as provided in Attachments C2 and C3. If sludge like material is identified, samples will be submitted for Target Compound List and Target Analyte List (TCL/TAL; minus cyanide) analyses. In addition, select samples will be collected and submitted for pH, moisture content, grain size analyses, total organic carbon (TOC), and oil and grease. A minimum of one sample of sludge material from each boring will be collected and submitted for laboratory analysis. If the sludge material is greater than 4 feet in thickness in a given boring (for borings GB-01 through GB-04), then two samples from each boring will be collected and submitted for analyses. If sludge similar to that previously encountered at B-1 is not identified, then one sample from each of these borings, based on apparent worst case field observations will be selected for analyses. The number of soil borings and samples collected for analyses will depend on the number of soil borings that encounter sludge material. A detailed written procedure of the biased soil boring and sampling program is described in Section 5.1.2 of the Work Plan. Sampling procedures are described in Section 2.4 of this plan.

It should be noted that boreholes may meet refusal due to the presence of construction debris prior to encountering natural materials. A maximum of three boreholes will be attempted approximately 5 feet from each other at any one boring location.

### ***Geotechnical Investigation***

A relatively undisturbed sample of the meadow mat layer beneath the potential "hot-spot" area will be obtained using Shelby tube samplers. Shelby tube sampling will be conducted in general accordance with ASTM D1587 Standard Practice for Thin-Walled Tube Sampling for Soils. A three (3)-inch OD Shelby will be connected to a head assembly and lowered down the borehole. The Shelby tube will be pushed into the meadow mat layer using a slow steady pressure with no rotation. The tube will be left in place approximately 5-10 minutes to dissipate negative pore pressures. The tube will then be sheared from the in-situ soils, by turning the drill rods, and then raised to the surface. The total recovery of the sample will be measured and the tube will be labeled, capped and sealed with wax or paraffin.

The borehole will then be advanced, as described for the B-1 area boring investigation, to the top of the upper glaciolacustrine varved unit and a relatively undisturbed sample collected with a Shelby



tube as described above. The tubes will be transported to the geotechnical laboratory as soon as practicable in a manner which minimizes disturbance. A maximum of two samples from each unit will be tested for moisture content (ASTM D2216), Atterberg Limits (ASTM D4318), and consolidated undrained triaxial compressive strength with pore water pressure measurements (ASTM D4767). The samples will be selected for laboratory analysis based on recovery and sample integrity.

## **2.4 Analytical Sampling Procedures**

### ***Overview***

Sample collection of the subsurface materials will be completed at boring locations GB-01 through GB-04 for TCL/TAL constituents (minus cyanide). Samples may also be collected from additional borings, if necessary, as described in Section 5.0 of the FFSI Work Plan. In addition, select samples of the subsurface material will be collected and submitted to the chemical laboratory for TOC, and oil and grease analysis and to the geotechnical laboratory for pH, grain size, and moisture content analyses. Because the field investigation has been designed to be flexible so as to meet the project objectives, the exact number of borings and number of samples collected for chemical and geotechnical analyses will be determined in the field. Guidelines for the selection of laboratory samples are discussed in Section 5.0 of the FFSI Work Plan text. At the end of each day the field supervising geologist/engineer, with concurrence from the USEPA oversight contractor, will determine the appropriate samples to submit to the laboratory for analysis. Samples will not be collected from borings which are installed for the purpose of delineating only physical characteristics at the extremities of the investigation areas.

During the B-1 area investigation, a sample from each split-spoon will be collected and treated as though the sample will be submitted to the analytical laboratory for analysis (e.g., placed in laboratory sample jars and preserved in a cooler). If a boring investigation is necessary for the former pond areas, samples of similar material submitted for analysis from the B-1 area investigation will be collected and submitted to the analytical laboratory.

The type and size of each sample bottle and preservation procedures are described in the QAPP provided in Appendix D (Tables D7 and D8). QA/QC samples will include field duplicates, rinsate blanks, and MS/MSD. The collection frequency of QA/QC samples is identified in the QAPP

provided in Appendix D (Table D4). General sampling considerations and documentation and procedures for handling of quality control samples, sample preservation, chain-of-custody, and sample shipping are provided in Attachment C4. These procedures are consistent with the NJDEP Field Sampling Procedures Manual (May 1992). During decontamination procedures and sampling, all field personnel will wear "phthalate-free" gloves.

All sampling equipment will be decontaminated prior to use at each location in accordance with the procedures outlined in Section 3.0.

### ***Sample Collection***

Samples of the subsurface material will be collected from 2 foot intervals and analyzed for TCL/TAL (minus cyanide). In addition, samples will be submitted for grain size analysis, pH, moisture content, TOC, and oil and grease. The samples will be collected with a decontaminated 3-inch OD split-spoon sampler. Samples collected for the TCL volatile organic analysis will be collected from a discrete 6-inch interval which will be biased toward intervals of apparent contamination noted visually and/or with an organic vapor monitoring instrument. A sample of the material will also be placed in a plastic zip-lock bag for headspace analysis. The surficial VOC sample from the 0-2 foot interval will be collected from the bottom 6-inch interval (18-24-inches) and added directly to the laboratory sample container with a stainless steel spoon or spatula.

After the volatile organic sample is collected, the remaining material will be placed in a decontaminated stainless steel mixing bowl or tray. Large rocks, twigs, roots, and leaves will be removed. The material will be homogenized with a decontaminated stainless steel spoon or spatula prior to filling the remaining sample containers. The sample will be homogenized according to the procedure below:

- The sample should be scraped from the sides, bottom, and any corners of the pan or bowl and rolled into the middle of the mass using a stainless steel spoon or spatula.
- The mass of the sample should be mixed thoroughly. The sample should be divided into four equal quarters, which should be moved to separate parts of the pan or bowl. Each quarter should be individually mixed. The four quarters should be recombined, and the entire mass mixed.

The remaining sample containers for SVOC, pesticide/PCB, metals, TOC, and oil and grease analysis will be filled with the homogenized soil.

All sampling procedures will be performed in accordance with NJDEP Field Sampling Procedures Manual (May 1992).

### ***Sample Identification***

The following sample identification (ID) number scheme, for samples submitted for chemical analysis, will be used to define the different media and different quality control samples. The samples will be assigned up to an 8-digit alpha-numeric identification number as follows:

1    2    3    4    5    6    7    8

The 1st digit is used to indicate type of QC sample as follows:

R	rinsate blank
F	field duplicate
O	if not a QC sample

Digits 2 and 3 indicate the matrix as follows:

FF	Fill (for fill material samples above meadow mat or grey silt)
----	--

The fourth, through eighth digits are numeric fields indicating the sample number and are assigned as follows:

- For primary samples, this will be the boring number with a letter suffix where "A" represents the 0-2 foot interval, "B" represents the 2-4 foot interval, etcetera.
- For QC samples (rinsate blank) this will be a sequentially assigned number
- For field duplicates this will be the location at which the duplicate was taken.

Examples of ID numbers are as follows:

OFF01B	primary fill sample from boring GB-01 at the 2-4 foot interval
FFF01B	field duplicate of fill sample collected from boring GB-01 at the 2-4 foot interval

---

### **3.0 DECONTAMINATION PROCEDURES**

#### **3.1 Drill Rigs and Drilling Equipment**

Drill rigs and downhole drilling equipment used at the site will be decontaminated prior to use at the Site, between boreholes, and prior to demobilization from the Site. Decontamination will include steam cleaning and manual scrubbing, as necessary, to remove any visible contamination. Decontamination will be conducted at the designated decontamination area at all times. The designated decontamination area will be at the approximate location shown on Figure C1.

#### **3.2 Sampling Equipment**

Decontamination of split-spoon samplers and other field sampling equipment used for the collection of samples for laboratory analysis will be performed at each borehole as follows:

1. Wash and scrub with low phosphate detergent;
2. Tap water rinse;
3. Rinse with 10% HNO<sub>3</sub>, ultrapure\*;
4. Tap water rinse;
5. Methanol followed by hexane rinse (pesticide grade or better);
6. Air dry; and
7. Wrap in aluminum foil.

\* If split-spoon sampling device is composed of carbon steel, the HNO<sub>3</sub> rinse will be lowered to a concentration of 1%.

The sampling equipment decontamination procedures are believed sufficient to meet the project objectives (i.e., quantifying elevated levels of impacts as part of the "hot-spot" delineation).

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**TABLE C1**  
**SUMMARY OF FIELD INVESTIGATION**  
**FOU FILL - FOCUSED FEASIBILITY STUDY**  
**216 PATERSON PLANK ROAD SITE**

INVESTIGATION ACTIVITY	LOCATION	OBJECTIVE	RATIONALE
Geophysical Survey	B-1 and Former Pond Areas	- Define the approximate boundary of the B-1 area and provide a more in-depth understanding of the subsurface material (e.g. sludge material similar to the B-1 area)	Identify areas potentially containing sludge material to help with the placement of the soil borings for the B-1 and former pond areas.
Soil Borings GB-01 through GB-04	Boring B-1 Area	- Borings to define the extent and consistency of sludge material previously identified - Laboratory analytical program to define chemical characteristics of sludge material or FOU fill for TCL and TAL analysis (minus cyanide). Additional analysis to include pH, moisture content, grain size analysis, TOC & oil and grease	Fill data gaps associated with defining potential "Hot Spot" identified during Phase I of the FFS. Data will be used to assess potential risk from "hot-spot" area to complete the Detailed Analysis of Remedial Alternatives (FFS Phase II).
Soil Borings (1)	Former Pond Area	- Verify the presence of sludge material similar to area B-1 - Laboratory analytical program to define chemical characteristics of sludge material or FOU fill for TCL and TAL analysis (minus cyanide). Additional analysis to include pH, moisture content, grain size analysis, and TOC & oil and grease	Fill data gaps associated with defining potential "Hot Spot" identified during Phase I of the FFS. Data will be used to assess potential risk from "hot-spot" area to complete the Detailed Analysis of Remedial Alternatives (FFS Phase II).
Geotechnical Sampling (2)	Boring B-1 Area	- Collect potentially undisturbed samples of the meadow mat and upper glaciolacustrine varved unit for geotechnical analysis	Provide geotechnical data to evaluate sideslope stability for potential excavation of "hot-spot" area. Data will be used to complete the Detailed Analysis of Remedial Alternatives (FFS Phase II).

Note:

(1) - A soil boring investigation of the former pond area will be performed based on the results of the geophysical survey and the B-1 area boring investigation.

(2) - Location of these borings will depend on the thickness of the meadow mat material encountered during the B-1 area soil boring investigation.

Refer to Figure C-1 .

Attachment C4

General Sampling Procedures

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## **1.0 GENERAL SAMPLING CONSIDERATIONS AND DOCUMENTATION**

### **1.1 Purpose**

The General Sampling Considerations and Documentation requirements given in Sections 1.3 and 1.4 below are intended to guide the overall field sampling effort and produce valid sample results.

### **1.2 Equipment**

The following equipment and materials are required for this procedure:

- Sampling, Analysis and Monitoring Plan (SAMP);
- Quality Assurance Project Plan (QAPjP);
- Health and Safety Plan (HASP)
- Field notebooks (pages numbered consecutively);
- Water-proof markers;
- Sample collection forms;
- Chain-of-custody forms and seals;
- Sample bottle labels;
- Packing tape;
- Camera and film;
- Sampling gloves; and
- Location map.

### **1.3 Procedure**

#### **1.3.1 General Sampling Considerations**

- The main text of the SAMP should be consulted for information on existing site data, sampling objectives, sample locations and frequency, sample designations, sampling equipment and procedures, sample handling and planned analyses, and investigation-derived waste handling procedures. Much of the information in the main text of the SAMP is repeated in the procedures given below, but both sources of information should be reviewed prior to sampling.
- A new pair of phthalate-free powderless gloves (inner latex, outer NBR) should be worn by the sampler at each sample location.
- The minimum sample volumes given in the appropriate tables of the QAPjP are required to complete an analysis. The number and size of bottles have been specified to provide the laboratory with enough sample to perform two analyses for each parameter at a given sample point.
- If at any time the field team is in doubt as to the proper sampling procedures, the Golder Associates Project Manager or the Golder Associates Quality Assurance Officer should be contacted.
- Any changes to these procedures must be discussed with the Golder Associates Project Manager for approval in advance of implementation. The on-site representative of



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USEPA should also be consulted to document approval of the change using the Field Change Request Form.

### 1.3.2 Documentation

- Proper documentation of field activities is essential. Required information for each sample includes:

- Project or site name;
- Sample collection date and time;
- Sampler's name;
- Sample point identification number and matrix;
- Designation as a grab or composite sample;
- Analysis method requested; and
- Any sample filtration or preservatives used in the field.

The sample point identification, collection date/time, and requested analysis must be included on the sample bottle label. The individual collecting the sample should initial the bottle labels. All of the above information should be entered on the chain-of-custody form and sample collection forms.

- Objective field notes should be produced which summarize adherence to SAMP procedures and the chronology of events.
- Sample collection forms may be used to document much of the information in lieu of field notebooks. However, the sample bottle labels and chain-of-custody form should not be the only place where pertinent information is recorded in case discrepancies occur between the sample bottle labels and the chain-of-custody forms.
- Calibration of field meters should be documented including:
  - Analysts name;
  - Date and time of calibration;
  - Instrument type, model number, and serial number (if present); and
  - Manufacturer, concentration, and lot number of calibration standards which are used.
- Each page of the field notebooks should contain the sampler's name, project number, and date. All field notes must be legible. Any errors should be crossed out with a single line and initialed.
- Photographs should be taken of representative procedures. The condition of any damaged monitoring wells should also be photographed. Photographs must be documented in field notebooks including:
  - the photograph number;
  - photographer's name;
  - date/time;
  - description of subject; and
  - perspective.

This information should be transcribed onto the back of the photographs after they have been developed.

## **2.0 PROCEDURE FOR COLLECTION AND HANDLING OF QUALITY CONTROL SAMPLES**

### **2.1 Purpose**

Quality Control (QC) samples are used to evaluate the precision, accuracy, and representativeness of the sample data. A number of QC samples, such as equipment rinsate blanks, field duplicates, and matrix spike/matrix spike duplicates (MS/MSDs) are required for this project. Each of the above QC samples require special consideration by the sampling team. The various QC samples are identified in the SAMP and QAPjP. The on-site USEPA representative might also wish to collect split samples from the various sample locations, as well as QC samples for the split samples (i.e. field duplicates, MS/MSDs, rinsate blanks).

### **2.2 Equipment**

The following equipment and materials are required to perform this procedure:

- Demonstrated analyte-free water; and
- Sample bottles.

Equipment rinsate blanks are prepared using demonstrated analyte-free water supplied by the analytical chemistry laboratory. A batch analysis of the water will be supplied by the laboratory along with the water. The analytical results must be reviewed to evaluate whether it conforms to the project requirements prior to use. In order to be demonstrated analyte-free, the water analysis results should not detect any targeted analytes above the Contract Required Quantitation Limit (CRQL) for Target Compound List (TCL) organic compounds (including volatiles, semivolatiles, and pesticides/PCBs) and the Contract Required Detection Limit (CRDL) for inorganics (metals and cyanide). The CRQL and CRDL will be listed for each analyte on the analysis report.

As defined in the CLP SOW, exceptions to the above criteria are allowed for the following common laboratory contaminants: methylene chloride, acetone, toluene, 2-butanone, and the various phthalates. These common laboratory contaminants must not be detected at concentrations greater than three times the CRQL, but total volatile organics must be less than 10 parts per billion (ppb). All of the above compounds are VOCs except the phthalates.

The analytical results for the blank water must be kept on site during sampling in case USEPA wishes to audit the results. The analytical results should be placed in the project files in the home office after sampling is completed. Because demonstrated analyte-free water is also used in sampling equipment decontamination, the field team must be cognizant of the amount of water needed as the project progresses and notify the laboratory several days in advance if additional water is needed.

### **2.3 Procedure**

#### **2.3.1 General Considerations**

- Most QC samples (i.e. field duplicates and MS/MSDs) are collected at a frequency of one per batch of up to twenty field samples. A batch of up to twenty field samples is defined to include primary samples and field duplicate samples only. Equipment

rinsate blanks are collected at a rate of one per decontamination event for each type of equipment used (not to exceed one per day per equipment type). Trip blanks, equipment rinsate blanks, and MS/MSD samples are not counted as part of the batch of twenty field samples.

- Equipment rinsate blanks are required for this project.
- QC samples are preserved in the same manner as primary samples and must be stored in a cooler during the sampling day and shipment to the laboratory.

### **2.3.2 Equipment Rinsate Blanks**

- Equipment rinsate blanks must be collected in several situations. Soil samples will be collected using non-dedicated sampling devices and homogenized using stainless steel bowl and spoon. All equipment which contacts the sample must be exposed to demonstrated analyte-free water in order to collect a valid rinsate blank.
- One batch of water can be successively exposed to each piece of equipment, and finally poured into sample jars.
- Rinsate blanks should be collected after the equipment has been decontaminated as described in Section 3.0 of the SAMP.
- Rinsate blanks are collected at frequency of one per decontamination event for each type of equipment used (not to exceed one per day per equipment type).
- Rinsate blanks should be collected for all analytical parameters.

### **2.3.3 Field Duplicates, MS/MSDs, and Split Samples**

- Field duplicates and MS/MSD samples are required for all matrices at a rate of one per 20 field samples.
- Field duplicates should be collected for all analytical parameters and assigned up to an 8-digit alpha-numeric identification as described in Section 2.4 of the SAMP.
- MS/MSDs are actually extra sample volume for an existing sample. Therefore, the multiple sample bottles for MS/MSD analysis should be labeled in an identical manner, and the chain-of-custody form should indicate that this sample is designated for MS/MSD analysis.
- Sample bottles for split samples (also sample bottles for field duplicates and extra sample bottles for MS/MSDs) should be filled one parameter at a time (i.e. all the VOC bottles, then all the metals bottles, etc.).

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### 3.0 PROCEDURE FOR SAMPLE PRESERVATION

#### 3.1 Purpose

The following procedure should be followed to preserve environmental samples for laboratory analysis such that the representativeness of the sample is maintained prior to analysis to the extent possible.

#### 3.2 Equipment

The following equipment and materials may be required to perform this procedure:

- Frozen blue ice packs or wet ice;
- Spare sample bottles;
- Several eye droppers;
- pH test strip paper;
- 30% hydrochloric acid (HCl);
- 30% Sulfuric acid (H<sub>2</sub>SO<sub>4</sub>);
- 30% Nitric acid (HNO<sub>3</sub>); and
- 10N Sodium hydroxide (NaOH).

#### 3.3 Procedure

##### 3.3.1 General Requirements

- Sample preservation requirements are given for aqueous and soil samples in tables in the QAPjP.
- The only preservative procedure required for soil samples is cooling to 4°C in a cooler immediately after collection. This temperature should be maintained during storage and shipment to the laboratory.
- Aqueous samples should be cooled to 4°C in a cooler immediately after collection. This temperature should be maintained during storage and shipment to the laboratory.
- Sample preservation kits will be provided by the laboratory along with the sample bottles.
- It should be noted that some samples, such as VOCs, require addition of hydrochloric acid (HCl) while others, such as metals, require the addition of nitric acid (HNO<sub>3</sub>) and others, such as ammonia, require addition of sulfuric acid (H<sub>2</sub>SO<sub>4</sub>). Cyanide samples should be preserved using NaOH. Be certain that the proper chemical preservative is added to each jar.
- Separate procedures for preservation of VOC and non-VOC samples are provided below.

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### 3.3.2 VOC Samples

- Soil VOC samples should fill the container as much as possible in order to minimize the sample headspace, and should be stored and shipped in an inverted position (i.e. cap facing down). Samples should be maintained at 4°C at all times after collection.
- The only aqueous sample collected will be the equipment rinsate blank. An extra sample vial will be used to determine the number of drops of HCl required to attain a pH less than 2.
- Initially, six drops of HCl should be added.
- The vial cap should be replaced and the vial inverted several times to mix the sample.
- The cap should be removed and a pH indicator strip dipped into the vial.
- The color of the strip should be compared to the color chart provided with the strips.
- Repeat the above procedure until a pH less than two has been attained. HCl should be added one drop at a time.
- Discard the test vial, and carefully add the same number of drops of acid to the remaining VOC vials.
- Replace the cap and invert each vial several times to mix the sample.

### 3.3.3 Non-VOC Samples

- Soil Non-VOC samples should fill the container as much as possible, and should be stored and maintained at 4°C at all times after collection.
- Non-VOC samples should also be checked to assess the required amount of chemical preservative to attain the pH specified in the appropriate QAPjP table. The only aqueous samples collected will be for the equipment rinsate blank.
- Separate sample bottles are not required to check the pH because non-VOC sample bottles are permitted to contain headspace. The preservation procedure is given below.
- Initially, four drops of preservative should be added.
- The cap should be replaced and the bottle inverted several times to mix the sample.
- A few milliliters of sample should be poured into a separate container (e.g. an unused sample jar cap) and the pH checked using indicator paper.
- Additional acid should be added two drops at a time and the above procedure repeated until the specified pH is attained.

- 
- For cyanide samples, sodium hydroxide (NaOH) pellets might be supplied by the laboratory. These pellets should be added one at a time, and the sample mixed until the pellet has completely dissolved.
  - After some of the initial samples have been preserved, the sampler can increase the initial number of drops (or pellets) added if necessary based upon the approximate amount of sample required for other locations.

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## **4.0 PROCEDURE FOR FIELD CHAIN-OF-CUSTODY**

### **4.1 Purpose**

Samples are physical evidence collected from a facility or the environment. Sample data generated during environmental projects may be used as evidence in legal enforcement proceedings. In support of potential litigation, chain-of-custody procedures have been established to ensure sample traceability from the time of collection through completion of analysis.

### **4.2 Equipment**

The following equipment and materials may be needed to perform chain-of-custody procedures:

- Chain-of-custody forms;
- Chain-of-custody seals; and
- A secure (locked) vehicle or building.

### **4.3 Procedures**

- Chain-of-custody is usually initiated in the field by the sampling team.
- When chain-of-custody is initiated at the laboratory, the laboratory personnel responsible for shipping sampling containers will have initiated and signed the chain-of-custody form and sealed the shipping container with a chain-of-custody seal. It is preferable for the custody seal to be signed and dated by the laboratory and to have a unique serial number which is recorded on the chain-of-custody form by the lab. In such cases, field staff should check this information to assess the potential for tampering with sample containers prior to receipt in the field. The field staff should acknowledge receipt and container integrity by signing the chain-of-custody form, and noting any discrepancies.
- It is preferable to use laboratory-supplied sample containers. The bottles for this project will be supplied by the laboratory. CompuChem purchases their bottles from Eagle-Pitcher who prepares the glassware in accordance with OSWER directive # 9240.0-05A. Eagle-Pitcher provides CompuChem with certificates of cleanliness; copies of these certificates will be provided with the bottles to the field sampling crew. However, if a situation arises where the field team uses any sample containers not supplied by the laboratory (such as pre-cleaned and certified I-Chem bottles), this should be noted on the chain-of-custody form for the particular samples in question.
- Samples and sample containers must be kept under proper chain-of-custody during field sampling. The National Enforcement Investigations Center (NEIC) of USEPA considers a sample in custody under the following conditions:
  - It is in your actual possession; or
  - It is in your view, after being in your physical possession; or
  - It was in your possession and then you locked or sealed it to prevent tampering; or
  - It is in a secure area (such as a locked site trailer, or a locked site vehicle).



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- If custody of the samples (and sample bottles) is exchanged during field sampling, such transfer must be documented on the chain-of-custody form. The departing field staff should sign indicating the custody has been relinquished, and the arriving field staff should sign indicating responsibility for the custody of the samples.
  - Each sample bottle label should include:
    - Project name and code;
    - Sample point identification number;
    - Sample collection date/time;
    - Analytical method to be performed; and
    - Initials of individual collecting the sample.
  - The chain-of-custody form and sample collection forms should include:
    - Sample identification number and matrix;
    - Project or site name;
    - Sampler's name;
    - Sample date and time (military time);
    - Designation as a grab or composite sample;
    - Requested analysis;
    - Whether the sample was filtered;
    - Any preservatives added to the sample; and
    - Any special notations regarding the sample.
  - When shipping samples to the laboratory, all sample bottles and requested analyses should be noted on the chain-of-custody form.
  - Where multiple analytical methods are available for a particular analysis, the specific method number should be listed on the chain-of-custody form. For example, groundwater samples for VOC analysis might be performed by USEPA Methods 601, 602, 624, or CLP-RAS (Contract Lab Program-Routine Analytical Services).
  - Any sample filtering or preservation should be noted on the chain-of-custody form.
  - If required and appropriate for the project, the chain-of-custody form must indicate whether there are any additional target analytes for TCL analysis. It should also indicate where triple sample volume has been supplied for MS/MSD analysis.
  - The form should also note that only one of the two trip blank vials should be analyzed by the laboratory.
  - The sampling technician should sign the chain-of-custody form relinquishing custody to the laboratory.
  - Record the airbill number on the chain-of-custody form in the comments section.
  - The field sampling crew should keep one copy of the completed chain-of-custody form along with a copy of the airbill.

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- The chain-of-custody form should be sealed inside the shipping container with the samples. The paperwork should be sealed inside a ziplock bag to prevent damage from water condensation or broken sample bottles.
  - The courier does not need to sign the chain-of-custody form if it is sealed within the shipping container using custody seals.
  - If samples are hand delivered to the laboratory by the field staff, the chain-of-custody form should be signed at the laboratory when the samples are delivered and the shipping container does not need to be sealed as long as it is kept under proper chain-of-custody until delivered to the laboratory.
  - If possible, chain-of-custody seals should be signed and dated, and the serial numbers listed on the chain-of-custody form. At least two seals should be used on each shipping container.
  - Field staff should return their copy of the chain-of-custody form to the project office as soon as possible. If field records are sent via U.S. mail or overnight courier, the field staff should keep another copy of the form until receipt by the project office has been confirmed.

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**5.0 PROCEDURE FOR SAMPLE SHIPPING****5.1 Purpose**

The following procedure is to be used to enhance successful shipping of samples to the laboratory.

**5.2 Equipment**

The following equipment and materials may be required to perform this procedure:

- Overnight courier airbills and courier phone number;
- Fiber reinforced strapping tape;
- Cushion material such as bubble wrap or vermiculite;
- Address labels;
- Laboratory address and phone number; and
- Custody seals.

**5.3 Procedure**

- Samples should be packed into a shipping container (usually a cooler) in a manner which will minimize potential breakage of sample bottles. This might include use of laboratory-supplied bubble wrap designed to fit the particular bottle, polystyrene chips, or vermiculite.
- Soil VOC samples should be shipped in an inverted position (i.e. with the cap pointing downward).
- The sample containers must contain enough frozen blue ice packs to maintain a temperature of 4°C during transport to the laboratory.
- Record the airbill number of the overnight courier on the chain-of-custody form in the comments section.
- The field sampling crew should keep one copy of the completed chain-of-custody form along with a copy of the airbill.
- The chain-of-custody form should be sealed inside the shipping container with the samples. The paperwork should be sealed inside a ziplock bag to prevent damage from condensation of water or broken sample bottles during shipping.
- The courier does not need to sign the chain-of-custody form if it is sealed inside the shipping container using custody seals.
- If samples are hand delivered to the laboratory by the field staff, the chain-of-custody form should be signed at the laboratory when the samples are delivered and the shipping container does not need to be sealed as long as it is kept under proper chain-of-custody until delivered to the laboratory.

- 
- If possible, chain-of-custody seals should be signed and dated, and the serial numbers listed on the chain-of-custody form. At least two seals should be used on each shipping container.
  - Samples must be shipped to the laboratory within 24 hours of collection. For local laboratories, courier service or drop off at the laboratory may be available. Otherwise samples should be shipped via overnight delivery service (e.g., Federal Express). Samples collected on Friday must be shipped for Saturday delivery. Verify with the laboratory that someone will be at the laboratory to receive the samples.
  - Field staff should return their copy of the chain-of-custody form to the project office as soon as possible. If field records are sent via U.S. mail or overnight courier, the field staff should keep another copy of the form until receipt by the project office has been confirmed.
  - The field sampling team should notify the Golder laboratory coordinator of the quantity and types of samples shipped each day as soon as possible. If there are discrepancy on the paperwork received by the laboratory, or if any sample bottles are received broken, the laboratory will notify the Golder laboratory coordinator, who will subsequently consult with the Golder Project Manager and Golder Quality Assurance Officer to determine if resampling is necessary.

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**APPENDIX D**  
**Quality Assurance Project Plan**

**Golder Associates Inc.**

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**APPENDIX D**

**QUALITY ASSURANCE PROJECT PLAN  
FOR FOCUSED FEASIBILITY STUDY INVESTIGATION  
216 PATERSON PLANK ROAD SITE  
CARLSTADT, NEW JERSEY**

May 1997

Revision # 1

	Signature	Date
Golder Associates Project Manager	<u>Stuart M. H.</u>	5/15/97
Golder Associates Project QA Manager	<u>Lois Anne Hendel</u>	5/15/97

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## 1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) has been prepared by Golder Associates Inc. (Golder Associates) as part of the Focused Feasibility Study Investigation Work Plan (FFSI Work Plan) to provide data needed to complete the next phase of the Focused Feasibility Study (FFS) for the 216 Paterson Plank Road Site (Site) in Carlstadt, New Jersey. This document describes the policy, organization and specific quality assurance (QA) and quality control (QC) elements necessary to achieve the objectives defined for the investigation. This QAPP is primarily intended to address QA/QC procedures which will govern chemical analysis (field and laboratory) of environmental samples which will be collected from the Site during the investigation.

This QAPP was prepared in accordance with the USEPA guidance documents specified below:

1. Interim Guidelines for Preparing Quality Assurance Project Plans (EPA-600/4-83-004, QAMS-005/80), dated February, 1983;
2. Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (EPA/540/G-89/004), dated October, 1988;
3. EPA NEIC Policies and Procedures Manual (EPA 330/9-78-001-R) dated May 1978, revised May 1986; and
4. Data Quality Objectives for Remedial Response Activities -Development Process (EPA/540/ G-87/003), dated March, 1987; and
5. Region II CERCLA Quality Assurance Manual, USEPA, Final Copy, Revision 1, October 1989.

The guidance documents specify sixteen (16) essential elements to be included in a QAPP. The first two (2) elements, Title Page (with provision for approval signatures) and the Table of Contents are included in the front of this document. The remaining fourteen (14) elements are presented in Sections 2 through 15.

CompuChem Environmental Corporation (CompuChem) of Durham, North Carolina is anticipated to provide primary analytical chemistry services to this project. CompuChem is a current Contract Laboratory Program (CLP) participant and is certified by the New Jersey Department of

Environmental Protection (NJDEP). In addition, CompuChem is currently providing analytical testing services in connection with ongoing monitoring at the site.

Many of the quality assurance procedures to be used for this project are described in the following documents:

1. Contract Laboratory Program (CLP) Statement of Work (SOW) for Organic Analysis (OLM03.2);
2. CLP SOW for Inorganic Analysis (ILM04.0);
3. CLP Organics Data Review and Preliminary Review, USEPA Region II SOP HW-6, Revision 9, December 1994;
4. Evaluation of Inorganic Data for the CLP, USEPA Region II SOP HW-2, Revision 11, January 1992; and
5. CompuChem Environmental Corporation Quality Assurance Plan (QAP), March 1995.

CompuChem's QAP has been provided as Attachment D1 to this QAPP. New Jersey certification for CompuChem is included in Attachment D2. CompuChem's QAP describes specific QA procedures which will be used for this project, as well as information regarding personnel, management structure, analytical equipment and instrumentation, and the laboratory facility. Where conflicting information appears in the main text of the QAPP as compared to the text in CompuChem's QAP, the information from the main text shall prevail.

The text of this document, which presents each of the thirteen remaining elements of a QAPP, refers to the CompuChem QAP, CLP SOWs and the FFSI Work Plan including the Sampling, Analysis and Monitoring Plan (SAMP, Appendix C of the FFSI Work Plan). This approach is in accordance with USEPA guidance documents which require that referencing of other documents be clearly defined in order to facilitate location of required information. Each section of this QAPP provides references to these documents as appropriate.

The signatures on the cover sheet of this QAPP demonstrate the review, approval, acceptance and responsibility for the Quality Assurance/Quality Control procedures specified herein by the project

team. A list of key personnel determined thus far for this project is presented as Table D1 of this QAPP.

All laboratories used during this project will be required to adhere to the provisions of this QAPP. The primary analytical laboratory chosen for this project (CompuChem) is a participant in good standing in the EPA's CLP Program and has demonstrated its ability to perform all tasks required under the CLP. Any revisions to this QAPP will be submitted to USEPA Region II for approval prior to implementation.

## **2.0 PROJECT DESCRIPTION**

The purpose of the project is to implement an investigation, which includes a Site-wide geophysical survey, a boring program to better conclusively define the characteristics of the "hot-spot" area at location B-1 and characterize the subsurface materials within the two former ponds, and a geotechnical investigation. The project objectives are detailed in Section 1.1 of the Work Plan. Implementation of the project consists of the following tasks:

1. Geophysical Surveys: focused in the areas of boring location B-1 and the two former pond areas;
2. Soil Boring Program: to define characteristics (areal extent, subsurface material types, and chemical constituent concentrations) within the potential "hot-spot" area at location B-1 and, based on the geophysical survey results, similar locations within the two former pond areas;
3. Geotechnical Sample Collection and Analyses: to provide geotechnical data for the meadow mat layer and upper glaciolacustrine varved unit below the potential "hot-spot" area; and,
4. Other field procedures required to completed the items above (e.g., decontamination).

Sampling to be performed under this project is summarized in Table D2. The sludge formerly sampled at the site from boring B-1 had elevated concentrations of organics and metals in the parts-per-million (ppm) range. Consequently, subsurface materials (sludge or FOU fill) will be analyzed for Target Compound List (TCL) organic compounds and Target Analyte List (TAL) metals, total organic carbon (TOC), and oil and grease. In addition, select sludge or FOU fill samples will be submitted for pH, moisture content, and grain size analysis which will be analyzed by Golder Associates' soils laboratory. As part of the geotechnical investigation, collection of samples of the meadow mat and upper glaciolacustrine varved unit will be submitted to test for physical and mechanical properties. Testing of these soil samples will also be performed by Golder Associates' soils laboratory.

### **3.0 PROJECT ORGANIZATION AND RESPONSIBILITIES**

The project will be performed by a qualified team of contractors retained by the Cooperating PRP Group. The Project Team organization is shown on Figure D1. Addresses and phone numbers for the key members of the project team are provided in Table D1 of this QAPP. It should be noted that these individuals have primary responsibility for the project although other individuals may be involved. The chain of communication shown on Figure D1 of the QAPP will be followed throughout the project.

The lead regulatory agency for the Site is the United States Environmental Protection Agency (USEPA) Region II. Golder Associates is the primary contractor responsible for the Investigation. Analytical chemistry services will be provided by CompuChem Environmental Corporation of Durham, North Carolina. Drilling and surveying contractors will be used as needed. Geotechnical analysis will be performed by the Golder Associates soil laboratory.

CompuChem's QAP (dated March 1995) is provided as Attachment D1. CompuChem's organizational structure is described in Section 4 of the QAP. A copy of the QAP for Golder Associates soils (physical/mechanical testing) laboratory is provided as Attachment D3.

#### **4.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT**

As part of the evaluation component of the QA program, results are compared with certain data quality indicators. These data quality indicators are part of the overall Data Quality Objectives (DQOs) for the project. The overall project DQOs are described in the Work Plan. DQO levels for physical/mechanical testing and chemical analysis for subsurface samples from the investigation are provided in Table D3. Table D4 provides details regarding the planned chemical analyses. QA program objectives for the analytical laboratory are presented in Sections 4 and 14 of CompuChem's QAP. In general, data quality indicators include precision, accuracy, representativeness, completeness, and comparability (PARCC). Each indicator may be defined as follows:

1. Precision is the agreement or reproducibility among individual measurements of the same property, usually made under the same conditions;
2. Accuracy is the degree of agreement of a measurement with the true or accepted value;
3. Representativeness is the degree to which a measurement accurately and precisely represents a characteristic of a population, parameter, or variations at a sampling point, a process condition, or an environmental condition;
4. Completeness is a measure of the amount of valid data obtained from a measurement system compared with the amount that was expected to be obtained under correct normal conditions; and
5. Comparability is an expression of the confidence with which one data set can be compared with another data set in regard to the same property.

QA objectives vary according to the specific objectives of each analysis. The levels of QA effort associated with the various types of analyses for a project such as this one are provided in Table D3. The accuracy, precision and representativeness of data will be functions of the sample origin, analytical procedures and the specific sample matrices. Quality Control (QC) practices used to evaluate these data quality indicators include use of accepted analytical procedures, adherence to hold time, and analysis of QC samples such as blanks, replicates, spikes, calibration standards and reference standards. Tables D5 and D6 summarize the PARCC criteria for samples which will be collected for laboratory measurements. Analytical reporting limits are provided in Attachment D4.

For each parameter analyzed, quantitative QA objectives for precision, accuracy and sensitivity (detection limits) were established in accordance with EPA CLP protocols (where appropriate), published historical data, laboratory method validation studies and laboratory experience with similar samples.

Representativeness is a non-quantitative (qualitative) characteristic which primarily addresses proper design of a sampling program in terms of number and location of samples and sample collection techniques. The rationale for the number and location of samples for this project is discussed in Section 5.0 of the FFSI Work Plan. Sampling procedures are described in the SAMP and Attachment C4 of the SAMP. The representativeness of the analytical data is also a function of the procedures used to process the samples. Wherever possible, standard USEPA or USEPA-accepted analytical procedures will be followed.

Completeness is a quantitative characteristic which is defined as the fraction of valid data obtained from a measurement system (sampling and analysis) compared to that which was planned. Completeness can be less than 100 percent due to poor sample recovery, sample damage, or disqualification of results which are outside of control limits due to laboratory error or matrix-specific interferences. Completeness is documented by including sufficient information in the laboratory reports to allow the data user to assess the quality of the results. The completeness goal for laboratory measurements will be 85%.

Comparability is a qualitative characteristic which allows for comparison of analytical results with those obtained by other laboratories. This may be accomplished through the use of standard accepted methodologies, traceability of standards to National Bureau of Standards (NBS) or USEPA sources, use of appropriate levels of quality control, reporting results in consistent, standard units of measure and participation in inter-laboratory studies designed to evaluate laboratory performance.

Samples collected during the project will be analyzed for parameters provided in Table D2. The DQOs, as summarized by the PARCC criteria on Tables D5 and D6, may not always be achievable.

The USEPA Region II data validation guidelines provide direction for the determination of data usability. Qualified data can often provide useful information, although the degree of certainty associated with the results may not be as planned. Professional judgment will be used to determine data usability with respect to project goals.



## 5.0 SAMPLING PROCEDURES

The ultimate accuracy of any data generation begins with a sampling and measurement procedure which is well conceived and carefully implemented. The details of the sampling procedures are provided in the SAMP (Appendix C of the FFSI Work Plan). The SAMP presents the procedures with which samples will be acquired or measurements made during the execution of the project.

### Changes in Procedures

Any major changes in sampling procedures as outlined in the SAMP and QAPP will be discussed with the PRP Group Facility Coordinator. Approval from the USEPA Remedial Project Manager will be needed prior to implementation of any major changes. Minor procedural changes will be made with the concurrence of the on-site USEPA representative. Changes will be documented in the field log books.

### Acquisition of Samples

The sampling procedures discussed in the SAMP address the following items as they have been determined thus far:

- A description of the planned sampling locations;
- A description of the sampling procedures to be used;
- A description of containers, procedures, reagents, etc., used for sample collection, preservation, transport and storage (Attachment C4);
- A description of sample preservation methods (Section 3.0 of Attachment C4);
- A discussion of the time considerations for shipping samples promptly to the laboratory (Section 5.0 of Attachment C4);
- Examples of the custody or chain-of-custody procedures and forms (see Figure D2 and Section 4.0 of Attachment C4);
- A description of the forms, notebooks, and procedures to be used to record sample history, sampling conditions, and analyses to be performed (Figure D2, Attachment C2 and Attachment C4); and
- A discussion of field QC checks such as field blanks, etc. (Section 2.0 of Attachment C4).

All samples shall be adequately marked for identification from the time of collection and packaging through shipping and storage. Marking shall be on a sample label attached to the sample container. Sample identification shall include, as a minimum:

- Project name and code;
- Sample identification number;
- Analysis requested;
- Sample date; and
- Initials of the individual performing the sampling (samples for chemical analysis).

Each sample will be assigned a unique sample identification number to be recorded on the sample label. Each sample identification number will be recorded in a sample log and, as applicable, on chain-of-custody documentation (see Figure D2). Designations for sample identification numbers for this project are described in Section 3.4 of the SAMP.

The methods and references for collecting samples are provided in the SAMP. Appropriately prepared sample containers are supplied by the laboratory. Reagents, preservation procedures and analytical holding times will be in accordance with the published analytical methods and USEPA Region II guidelines. Aqueous VOC samples (i.e., rinsate blanks) will be checked to ensure adequate acid has been added to attain pH <2.

The specific requirements for sample container preparation, sample preservation, and holding times, and any special sample handling requirements are listed in Tables D7 and D8. Sample containers will be kept closed until the time each set of sample containers are to be filled. After filling, the containers will be securely closed, residue wiped from the sides of the containers, and immediately placed in a cooler. Samples will be kept chilled and shipped on the day of sample collection to the laboratory via overnight delivery service.

## 6.0 SAMPLE CUSTODY

Samples are physical evidence collected from a facility or the environment. Sample data generated during this project may be used as evidence in USEPA enforcement proceedings. In support of potential litigation, chain-of-custody procedures have been established to ensure sample traceability from the time of collection through completion of analysis.

The National Enforcement Investigations Center (NEIC) of USEPA considers a sample to be in custody under the following conditions:

1. It is in your possession; or
2. It is in your view after being in your possession; or
3. It was in your possession and you locked it up; or
4. It is in a designated secure area.

All environmental samples will be handled under strict chain-of-custody procedures beginning in the field. The field sample custodian (team leader) will be responsible for ensuring that the applicable procedures outlined in of the SAMP (including Attachment C4) and relevant sections of this QAPP are followed. Sample custody for field activities will include the use of chain-of-custody forms, sample labels, custody seals, and field notebooks. Field notebooks will be used throughout the project to document all phases of field activities. Supplies and reagents (source and lot numbers, if appropriate) used for field measurements will be recorded in the field notebooks. An example of the Chain-of-Custody document to be used during sample collection is presented as Figure D2 of this QAPP. The CompuChem Chain-of-Custody form is provided in Section 7 of the CompuChem QAP.

Once samples are transported to the analytical laboratory, custodial responsibility is transferred to the Laboratory Sample Manager to assure that the procedures presented in the laboratory's QAP and the appropriate CLP SOW are followed. Sections 6 and 7 of CompuChem's QAP discuss laboratory Chain-of-Custody procedures.

The laboratory will keep final evidence files containing all relevant and appropriate project sample information. This sample information includes, but is not limited to the following items:

1. Chain-of-custody records;
2. Sample log-in information (if applicable);
3. Copies of laboratory sheets;
4. Copies of bench sheets;
5. Instrument raw data printouts;
6. Chromatograms;
7. Pertinent correspondence memoranda; and
8. Final report file.

Golder Associates will retain all relevant and appropriate project information in project files. The information contained in these files includes, but is not limited to, the following items:

1. Chain-of-custody records;
2. Field notes and information;
3. Correspondence and telephone memoranda;
4. Meeting notes;
5. Laboratory information;
6. Data validation information;
7. Reference information;
8. Audit information; and
9. Copies of reports.

These files will be retained for a minimum of six years as specified in the Administrative Order.

## 7.0 CALIBRATION PROCEDURES

Calibration procedures and frequency of calibration are described in the laboratory's QAP (Section 8) and in the SAMP (Attachment C4) and represent accepted techniques to ensure accurate sampling, monitoring, testing and documentation of field work as per quality assurance/quality control standards.

The major chemical analytical equipment used for this project are described in the CompuChem QAP, the CLP SOWs, and the individual analytical methods contained in Test Methods for Evaluating Solid Waste SW846, 3rd edition (November, 1986). A laboratory QAP provides information regarding types of equipment used by the laboratory facility. Section 13 of the CompuChem QAP contains this information. While the laboratory follows all specified procedures in the USEPA CLP SOW, various sources for calibration are used (for example, USEPA repository, NBS, Supelco, Aldrich and Chem Service). Sections 8 and 18 of the CompuChem QAP describes laboratory procedures for procurement of standard reference materials. The laboratory assures traceability of all stock solutions and working standards back to the neat material.

Samples may contain elevated levels of target analytes. These samples cannot be analyzed undiluted because the calibration range of the method would be exceeded. In accordance with the CLP SOW, these samples would require analysis at dilutions which will elevate the quantitation limits. Samples which do not contain concentrations of target analytes which exceed the instrument calibration range should be analyzed undiluted to achieve the lowest possible quantitation limits.

## 8.0 ANALYTICAL PROCEDURES

Most site characterization samples collected during this project will be analyzed, as appropriate, using CLP methodologies. Where CLP methodologies do not exist, samples will be analyzed using EPA-accepted methodologies. Non-CLP methodologies for both chemical and physical testing will be from the following documents:

Test Methods for Evaluating Solid Waste - Physical/Chemical Methods, SW-846, 3rd Edition, USEPA Office of Solid Waste, Washington, D.C., November 1986; and

Annual Book of ASTM Standards, Volumes 04.08 and 04.09, American Society of Testing and Materials, Philadelphia, PA, 1995.

CLP methods will be performed in accordance with the following documents:

USEPA Contract Laboratory Program, Statement of Work for Inorganic Analyses, Multi-media, Multi-concentration, (ILM04.0); and

USEPA Contract Laboratory Program, Statement of Work for Organic Analysis; Multi-media, Multi-concentration, (OLM03.2).

Method references for the analyses to be performed for this project are summarized in Tables D7 and D8. For sample analyses that are identified in Table D4, TCL/TAL analyses will be performed by CompuChem. Information regarding the laboratories' equipment is presented in Section 13 of the QAP. Laboratory qualifications (audit and/or performance evaluation results and certifications) are available from the laboratory.

The following project specific requirements will be followed during chemical analyses of samples for this investigation:

1. If the samples submitted to the laboratory are a sludge matrix, sample results will be reported on a wet weight basis. The sludge material is expected to have a high organic content and analysis for percent solids would not yield accurate results.
2. For sludge materials, preparation of samples for metals analysis will follow the same procedure as that followed for soil samples.
3. For sludge materials, the laboratory will prepare and analyze the samples for volatile organic compound (VOC) analysis and semi-volatile organic compound (SVOC) analysis using the medium level procedures described in CLP SOW OLM03.2 which allows for analysis of sludge.

4. The CLP SOW OLM03.2 does not have a medium level preparation procedure for pesticide/PCBs. For sludge materials, the laboratory will prepare and analyze the samples for pesticide/PCBs using a modified preparation procedure employing 1 gm of sample as opposed to 30 gpm. Samples will be analyzed using the procedures described in CLP SOW OLM03.2; the Contract Required Quantitation Limits (CRQLs), shown in Attachment D4, will be adjusted by a factor of 30.
5. For TCL/TAL analysis of FOU fill samples, preparation and analysis of organics and metals will follow the procedures described in the CLP SOWs for low concentration samples unless the concentrations of contaminants warrant medium level analysis.
6. For TOC analysis of sludge or FOU fill samples, the laboratory will perform the analysis using the Lloyd Khan method as suggested by the USEPA. Since there is no approved method for dilution of such samples, any sample concentration in excess of 16,000 ppm, will be reported as ">16,000 ppm".
7. For oil and grease analysis of sludge or FOU fill samples, the laboratory will prepare the samples using SW846 method 9071A and analyze the samples using USEPA method 413.2.

## 9.0 DATA REDUCTION, VALIDATION, AND REPORTING

Reduction of geophysical field data and its use to determine boring locations is discussed in the Work Plan and the SAMP. A detailed presentation of the laboratory data reduction, validation and reporting procedures is included in Section 10 of CompuChem's QAP. Reporting limits and units for each target parameter on the TCL/TAL lists are specified in the CLP SOWs and in Attachment D4. Results for sludge samples will be reported on a wet weight basis. The equations and/or procedures used to calculate concentrations are specified in the individual methodologies (refer to Tables D7 and D8 for method numbers and references).

For samples analyzed using CLP protocols, the laboratory will produce data packages which conform to the requirements of the CLP SOW. Data validation for data generated by CLP methodologies will be performed by the Golder Associates data validation specialist identified in Table D1. Data validation will be performed in accordance with the following current guidance documents specified by USEPA Region II:

1. USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, February, 1994;
2. USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, February, 1994;
3. Region II Standard Operating Procedure (SOP) No. HW-6, Revision 11 - CLP Organics Data Review and Preliminary Review, June, 1996; and
4. Region II SOP - No. HW-2, Revision 11 - Evaluation of Inorganic Data for the Contract Laboratory Program (CLP), January, 1992.

Qualified results will be reported for CLP samples on the forms provided in the CLP report packages or as data summary tables along with the laboratory deliverable package. Qualified results, data packages and analytical results will be stored in Golder Associates' project files. CLP deliverables, and raw data will be available for USEPA inspection at Golder Associates' Mt. Laurel, NJ office. A three (3) day advance notification to Golder Associates is requested to retrieve all appropriate files prior to USEPA inspection.



For analytical chemistry results generated by non-CLP methods, precision, accuracy, representativeness, comparability, and completeness will be evaluated based upon field sampling documentation, adherence to hold times and analysis of QC samples (duplicates, spikes and blanks). PARCC criteria are specified in Tables D5 and D6. QA review will be based upon method-specific QC criteria using the premises described in the Region II SOPs for data validation. Qualifiers will be applied to the data using the logic specified in the SOPs. Raw data (i.e. bench sheets) and batch QC data will also be reviewed. The overall responsibility for reporting laboratory data lies with the laboratory managers.

In accordance with standard industry practice, geotechnical testing results will not be formally validated.

The PARCC criteria and/or the criteria specified in the guidelines may not always be achievable. The data validation guidelines provide directions for the determination of data usability. Qualified data can often provide useful information, although the degree of certainty associated with the result may not be as planned. Professional judgment will be used to determine data usability with respect to DQOs and project goals.

The geophysical survey data from the initial ground-penetrating radar (GPR) and electromagnetic survey (FEM) field screening will be presented in the report containing the data collected during this investigation. The report will discuss how the field screening results were used to identify potential "hot-spot" areas and define the sampling network in the field.

## 10.0 INTERNAL QUALITY CONTROL

The laboratory chosen for this project (CompuChem) has an established quality control check program utilizing procedural (method) blanks, laboratory control spikes, matrix spikes, and duplicates. Details of the Internal QC checks utilized are specified in the CLP SOW and the laboratory's QAP (Section 11). Additional quality control will be performed utilizing rinsate or field blanks. These QC samples will be used to determine if sample constituents may be attributed to field activities or procedures used in sample transportation. Assessment of laboratory QC will take into account the PARCC criteria specified for this project (Tables D5 and D6). Attachment C4 of the SAMP discusses collection of QC samples (rinsate blanks, field duplicates and MS/MSDs) and preservation procedures.

Split samples may be collected by a USEPA contractor during the project. These samples will be collected separately and analyzed by a laboratory other than the laboratory chosen by Golder Associates. The EPA may choose to compare the laboratory results from the split samples with the results reported by Golder Associates' chosen laboratory for the same sample points. This comparison will demonstrate how well the results reported by two different laboratories are replicated.

The field activities will be performed in strict accordance with the procedures provided in the SAMP. Field or equipment rinsate blanks will be collected and analyzed to assess if sample contamination may be attributed to field activities. Control limits for accuracy and precision of field QC check samples may be found on Tables D5 and D6. The acceptable overall measurement error may be quantitatively expressed by the precision and accuracy goals for the data (Tables D5 and D6) which are representative of both sampling and analytical error.

## **11.0 PERFORMANCE AND SYSTEM AUDITS**

### **11.1 Performance**

Performance of activities or procedures will be maintained by the personnel responsible for such activities and procedures. The analyst and sample custodian will be responsible for performance within the laboratory. The performance of activities or procedures must comply with those specified in this QAPP and the SAMP. The responsible personnel must be prepared to justify that the specified procedure or reference method was implemented properly. Any deviation of a technical procedure or reference method must be noted within the appropriate log book and, for laboratory analyses, in the Case Narrative of the analytical report.

Reports regarding laboratory performance are discussed in Section 12 of CompuChem's QAP. The chosen laboratory is a current CLP participant for both organic and inorganic analyses and has demonstrated that it can perform all the tasks required by the CLP. The USEPA CLP requires successful performance of pre-award Performance Evaluation (PE) samples prior to acceptance into the program. Once established in the program, a laboratory must continue to demonstrate performance capabilities by successfully analyzing blind samples sent by the USEPA at designated intervals. The laboratory also participates in the water supply and/or water pollution series of PEs sponsored by the Quality Assurance Branch of USEPA. Successful analysis of these samples is required as part of the laboratory certification process for the environmental agencies for several states.

Performance will be monitored in the field through the use of QC checks as previously discussed in Section 10. Performance will be monitored in the laboratory through the use of QC checks discussed in Section 11 of the laboratory QAP and the PARCC criteria presented on Tables D5 and D6.

### **11.2 Audits**

The QA/QC audit is an independent systematic on-site review of facilities, equipment, training procedures, record keeping, data validation, data management, and reporting aspects of the field and laboratory QA/QC program. Audits may be performed on field operations and sampling procedures, laboratory analyses and documentation.

#### **11.2.1 Field/Sampling Audit**

Golder Associates does not plan an internal audit of field sampling activities as they are limited and will be performed in the course of doing other field activities. The field team leader will be responsible for ensuring that the applicable quality assurance procedures described in Attachment C4 of the SAMP and this QAPP are followed. Field activities may be audited by the on-Site USEPA representative, with respect to the technical requirements, procedures, and protocols established in the SAMP. These include:

Borehole activities, such as:

- Equipment decontamination; and
- Logging/field record keeping.

Field sampling activities, such as:

- Documentation of activities (logbooks, etc.),
- Use of proper sampling equipment;
- Proper sample identification;
- Sample preservation;
- Sample packaging;
- Sample shipment; and
- Chain-of-custody.

#### **11.2.2 Laboratory Audits**

The laboratory anticipated for this project (CompuChem) has been audited by the EPA and the NJDEP. The laboratory Quality Assurance Department will routinely conduct internal audits. Section 12 of the CompuChem QAP discusses internal laboratory audits. Golder Associates will not be performing audits of the laboratory during the project. However, if an external audit is deemed necessary by the USEPA, the USEPA and/or the USEPA oversight contractor will be responsible for their implementation. The most recent audit by the USEPA is provided in Attachment D1.

## 12.0 PREVENTIVE MAINTENANCE

Preventive maintenance of equipment is essential if project resources are to be utilized in a cost-effective manner. Preventive maintenance will ensure accuracy of measurement systems, minimize downtime, and provide inventory control of critical spare parts, back up systems, and other necessary equipment. Golder Associates will maintain an inventory of replacement parts for field instruments, and will routinely perform preventive maintenance or repair. Spare parts that often require replacement will be kept on hand at the Site during field activities. The following table summarizes the preventive maintenance approach for specific pieces of equipment used in field sampling, monitoring, testing and documentation.

### EQUIPMENT & ACCESSORIES

### PREVENTIVE MAINTENANCE AND INVENTORY

#### Sampling and Testing Equipment

Sample bottles, containers

Check prior to use for cleanliness, breakage and cracks; spare bottles; spare coolers; spare preservatives.

Distilled water

Spare distilled water.

Drill rigs

Check prior to use for cleanliness and leaking fluid; spare tools.

Split spoon

Check prior to use for cleanliness and to ensure soil catcher is properly attached; spare split spoon samplers, spare soil catchers.

Preventive maintenance of laboratory equipment and hardware is described in Section 13 of the CompuChem QAP. This section and the CLP SOW describe the instruments and equipment required to be present at the laboratory. More than one instrument is generally available for each type of analysis in case the initial instrument malfunctions or does not meet the required measurement criteria. Preventive maintenance and repair will be performed by laboratory personnel or qualified manufacturer representatives.

### 13.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA

Assessment of accuracy, precision and completeness of laboratory measurements is based upon the acceptable results from QC samples. Where appropriate these may include blanks, duplicate samples, laboratory control spiked samples or matrix spike/matrix spike duplicate samples.

Method and field/rinsate are expected not to contain any target analytes with concentrations greater than the reported detection limit with the possible exception of common laboratory contaminants.

Field and laboratory duplicate results are assessed based upon relative percent difference (RPD) between values, using the following equation:

$$RPD = \frac{(D1 - D2)}{(D1 + D2)/2} \times 100\%$$

where, D1 = Primary sample result; and,  
D2 = Duplicate sample result.

Laboratory control spiked samples are assessed based upon the percent recovery (%R) of spiked analytes. The percent recovery is calculated using the following equation:

$$\%R = \frac{X}{TV} \times 100\%$$

where, X = observed value of measurement; and,  
TV = "true" value of spiked analyte.

Matrix spike/matrix spike duplicate (MS/MSD) data are assessed based upon the percent recovery of spiked analytes using the following equation:

$$\% R = \frac{(SSR - SR)}{SA} \times 100\%$$

where, SSR = Spiked sample result for analyte x;  
SR = Sample result for analyte x; and,  
SA = Spike added of analyte x.

The relative percent difference between the MS/MSD results is calculated using the RPD equation presented above.

Data completeness is assessed based upon the amount of valid data obtained from a particular measurement system (sampling and analysis). It may be quantitatively expressed using the following equation:

$$\text{Completeness} = \frac{N1}{N2} \times 100\%$$

where, N1 = number of valid measurements obtained; and,  
N2 = number of valid measurements expected.

Section 14 of CompuChem's QAP describes the procedures which the laboratory uses internally to assess data which is produced. The laboratory assesses all quality control data with regard to precision and accuracy. Corrective actions are initiated as necessary.

Laboratory analytical data will be assessed by a Golder Associates data validation specialist to determine usability with regard to the DQOs which will be established for any sampling required. The data validation specialist is identified in Table D1. As mentioned in Section 9 of this QAPP, USEPA Region II guidelines will be used to validate CLP deliverables. PARCC criteria are presented on Tables D5 and D6.

As noted in the data validation guidelines, data may not always meet precision and accuracy requirements but may still be considered usable. The data will be assessed with regard to the project DQOs, and professional judgment will be used in determining data usability.

#### 14.0 CORRECTIVE ACTIONS

The need for corrective action is based upon predetermined limits for acceptability for all aspects of data collection and measurement. Predetermined limits for acceptability may include but are not limited to the PARCC criteria (Tables D5 and D6), historical data, laboratory control spike sample results, and experience using the analytical procedures for measurement in relation to the specific methodologies. By following standard quality control/quality assurance procedures, problems which could result in erroneous data can be detected. The need for corrective action may be determined by the samplers, analysts, supervisors, quality assurance personnel, laboratory managers or Project Managers.

Section 15 of CompuChem's QAP describes the Corrective Action procedures and documentation used by the laboratory to eliminate problems in the analytical systems. Any problems which can not be resolved by the analysts, laboratory managers or quality assurance officers will be brought to the attention of the Project Managers. The Golder Associates Project Manager, PRP Group Facility Coordinator, and USEPA Project Manager will determine the corrective action to be taken, if any.

The laboratory personnel will assess laboratory QC samples and re-analyze samples which do not meet QC criteria prior to expiration of hold times, when possible. Corrective actions for samples not meeting QC criteria may include re-analysis, or resampling and analysis. Laboratory personnel will use corrective action reporting forms to document identification and resolution of defects. These report forms will be kept on file in the laboratory QA files.

The detection of system and performance problems and the corrective actions procedures used in the field during sample collection will be documented in the field log books and placed in the project files. Any problems which can not be resolved by the sampler or field team leader will be brought to the attention of the Project Manager. The Golder Associates Project Manager, PRP Group Facility Coordinator, and USEPA Project Manager will determine the corrective action to be taken, if any.

If a system or performance audit uncovers problems requiring corrective action, the corrective action will be initiated upon approval of the responsible supervisor(s) and documentation of



corrective actions will be made in a letter report to the Program Managers/Coordinator. In this case, corrective actions will be reported to the Golder Associates Quality Assurance Officer and Project Manager, the PRP Group Facility Coordinator, the USEPA Quality Assurance Officer, and Region II Project Manager.

## **15.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT**

Timely Quality Assurance reports are necessary to the successful completion of this project. Quality assurance deficiencies in the field must be reported to the field team leader and the Golder Associates QA and project managers. Quality assurance deficiencies in the laboratory must be reported in a timely manner to laboratory and project management personnel. Expeditious initiation of corrective action will minimize the loss of data and time. Sections 4 and 16 of CompuChem's QAP discuss the laboratory's policies and procedures for reporting quality assurance activities to management. As mentioned in Section 14 of this QAPP, corrective actions for field and laboratory activities will be reported to the Golder Associates Quality Assurance Manager and Project Manager, the PRP Group Facility Coordinator, and the USEPA Quality Assurance Officer and Region II Project Manager.

In accordance with the Administrative Order, the PRP Group Facility Coordinator will provide monthly progress reports to USEPA which will include a summary of actions taken to achieve compliance with the Administrative Order and tasks set forth in the FFSI Work Plan, results of sampling, tests and validated analyses, identification of plans and deliverables submitted to the Agencies, description of problems encountered, any corrective actions taken during the preceding month and a description of data gathering and other activities planned for the upcoming two months. Any changes which need to be made to the QAPP will be noted in the progress report. Prior to initiation and implementation, these changes will be discussed with the USEPA Project Manager.

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TABLE D1

## KEY PERSONNEL

EPA Remedial Project Manager:	Jon Gorin USEPA Region II New Jersey Superfund Branch I 290 Broadway, 19th Floor New York, NY 10007-1866 Telephone: (212) 637-4361 Facsimile: (212) 637-4429
Facility Coordinator 216 Paterson Plank Road Cooperating PRP Group	P. Stephen Finn Golder Associates Inc. 305 Fellowship Rd. Suite 200 Mt. Laurel, NJ 08054 Telephone: (609) 273-1110 Facsimile: (609) 273-0778
Golder Project Manager:	Robert J. Illes Golder Associates Inc. 305 Fellowship Rd. Suite 200 Mt. Laurel, NJ 08054 Telephone: (609) 273-1110 Facsimile: (609) 273-0778
Golder Quality Assurance Officer:	Lori Anne Hendel Golder Associates Inc. 305 Fellowship Rd. Suite 200 Mt. Laurel, NJ 08054 Telephone: (609) 273-1110 Facsimile: (609) 273-0778
Golder Laboratory Coordinator:	Jeffrey R. Hendel Golder Associates Inc. 305 Fellowship Rd. Suite 200 Mt. Laurel, NJ 08054 Telephone: (609) 273-1110 Facsimile: (609) 273-0778
Chemistry Laboratory Project Manager: Chemistry Laboratory Project Coordinator:	Diane Ellmore Marlene Swift CompuChem Environmental Corporation 4600 Silicon Drive Durham, NC 27703 Telephone: (800) 833-5097 Facsimile: (919) 474-7031

**TABLE D1**  
**KEY PERSONNEL**

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Chemistry Laboratory QA Manager:	Linda Fowler
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TABLE D2

## SUMMARY OF ON-PROPERTY INVESTIGATION SAMPLING

FOCUSED FEASIBILITY STUDY INVESTIGATION				
SAMPLING POINTS	SAMPLING FREQUENCY	SAMPLING PARAMETERS	PURPOSE OF SAMPLING	DQO ANALYTICAL LEVELS <sup>(1)</sup>
B-1, GB-1 through GB-04 <sup>(2)</sup>	TBD	TCL organics, TAL metals, oil & grease, and TOC; pH, moisture content and grain size analysis	To obtain chemical and physical characteristics of the sludge like material within the "hot spot" area	DQO Level IV for TCL/TAL, DQO Level III for oil & grease and TOC; Other for pH, moisture content and grain size
Geotechnical Sampling <sup>(3)</sup>	TBD	Moisture content, Atterberg Limits, and Consolidated undrained triaxial compression with pore water pressure measurement.	To determine the geotechnical parameters of the material underlying the FOU within the "hot spot" area	Other

## Notes:

(1) DQO analytical levels are defined on Table D3 of the QAPP.

(2) Number and location of further sampling points will be determined in the field based upon field observations.

(3) Location of these borings will depend on the thickness of the meadow mat material encountered during the B-1 'hot spot' area investigation.

TBD = To be determined

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TABLE D3

## LEVELS OF QUALITY ASSURANCE AND ANALYTICAL DATA METHODOLOGIES

Level	Description	Associated On-Property Activity
I	Level I is the lowest quality data but provides the fastest results. Field screening or analysis provides Level I data. It can be used for health and safety monitoring and preliminary screening of samples to identify those requiring confirmation sampling (Level IV). The generated data can indicate the presence or absence of certain constituents and is generally qualitative rather than quantitative. It is the least costly of the analytical options.	- Health and safety monitoring
II	Level II data are generated by field laboratory analysis using more sophisticated portable analytical instruments or a mobile laboratory onsite. This provides fast results and better-quality data than in Level I. The analyses can be used to direct a removal action in an area, re-evaluate sampling locations, or direct installation of a monitoring well network.	- Not Applicable
III	Level III data may be obtained by a commercial laboratory with or without CLP procedures. (The laboratory may or may not participate in the CLP.) The analyses do not usually use the validation or documentation procedures required of CLP Level IV analysis. The analyzed parameters are relevant to site characterization risk assessment, and design of the remedial action.	- TOC and oil & grease
IV	Level IV data are used for risk assessment, engineering design, and cost-recovery documentation. All analyses are performed in a CLP analytical laboratory and follow CLP procedures. Level IV is characterized by rigorous QC protocols, documentation, and validation.	- Subsurface sludge and/or FOU fill material analysis of TCL and TAL parameters.
V	Level V data are those obtained by nonstandard analytical procedures. Method development or modification may be required for specific constituents or detection limits.	- Not Applicable
OTHER	Other: Methodologies not described above.	- Geotechnical Parameters

(1) EPA DQO Guidance Documents.

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TABLE D4

## Focused Feasibility Investigation - Target Analytes, Analytical Methods, and Quality Assurance Samples

Parameters	Matrix	Methodology	Number of Samples	Types of Samples <sup>(3)</sup>
Volatile Organics	Sludge or FOU fill material	CLP SOW <sup>(2)</sup>	TBD <sup>(1)</sup>	Primary
			TBD <sup>(1)</sup>	Field Duplicates
			TBD <sup>(1)</sup>	MS/MSD pairs
			TBD <sup>(1)</sup>	Rinsate Blanks
Semi-volatile Organics	Sludge or FOU fill material	CLP SOW <sup>(2)</sup>	TBD <sup>(1)</sup>	Primary
			TBD <sup>(1)</sup>	Field Duplicates
			TBD <sup>(1)</sup>	MS/MSD pairs
			TBD <sup>(1)</sup>	Rinsate Blanks
Pesticide/PCBs	Sludge or FOU fill material	CLP SOW <sup>(2)</sup>	TBD <sup>(1)</sup>	Primary
			TBD <sup>(1)</sup>	Field Duplicates
			TBD <sup>(1)</sup>	MS/MSD Pairs
			TBD <sup>(1)</sup>	Rinsate Blanks
Total Metals (no cyanide)	Sludge or FOU fill material	CLP SOW <sup>(2)</sup>	TBD <sup>(1)</sup>	Primary
			TBD <sup>(1)</sup>	Field Duplicates
			TBD <sup>(1)</sup>	Matrix Spike
			TBD <sup>(1)</sup>	Laboratory Duplicate
Oil and Grease	Sludge or FOU fill material	SW-846 9071	TBD <sup>(1)</sup>	Primary
			TBD <sup>(1)</sup>	Field Duplicates
			TBD <sup>(1)</sup>	Matrix Spike
			TBD <sup>(1)</sup>	Laboratory Duplicate
				Rinsate Blanks

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TABLE D4

## Focused Feasibility Investigation - Target Analytes, Analytical Methods, and Quality Assurance Samples

Parameters	Matrix	Methodology	Number of Samples	Types of Samples <sup>(3)</sup>
Total Organic Carbon	Sludge or FOU fill material	SW-846 9060	TBD <sup>(1)</sup> TBD <sup>(1)</sup> TBD <sup>(1)</sup> TBD <sup>(1)</sup> TBD <sup>(1)</sup>	Primary Field Duplicates Matrix Spike Laboratory Duplicate Rinsate Blanks
Geotechnical Parameters (4)	Soil (Meadow Mat)	see Table D8	1	Primary
Geotechnical Parameters (4)	Soil (Glaciolacustrine Varved Unit)	see Table D8	1	Primary
ASTM, pH, & Moisture Content	Sludge or FOU fill material	see Table D8	TBD <sup>(1)</sup>	Primary

## Notes:

- At this time it is not known how many samples will be collected and submitted for analysis. Objective and rationale of the sampling program is described in Section 5.0 of the Work Plan text.
- CLP Methodologies will include: CLP SOW OLM03.2 for Organics Analysis;  
CLP SOW ILM04.0 for Inorganics Analysis
- If samples are collected for chemical analysis, field duplicates will be collected, at a rate of 1 per twenty primary samples, as appropriate. Additional volume for MS/MSD will be collected at a rate of 1 per twenty primary and field duplicate samples, if possible. Laboratory will analyze MS/MSD, as appropriate. Field rinsate blanks for chemical analysis will be collected each day a decontamination event occurs.
- Specific geotechnical parameters are listed in Table D8.



TABLE D5

## PARCC DATA FOR NON-AQUEOUS SAMPLES

MEASUREMENT PARAMETER	METHOD REFERENCE	LABORATORY PRECISION	FIELD & LABORATORY PRECISION	ACCURACY	COMPLETENESS (a)
Volatile Organics-TCL	EPA-CLP	see Table D6	+/- 100%	see Table D6	85%
Semi-Volatile Organics-TCL	EPA-CLP	see Table D6	+/- 100%	see Table D6	85%
Pesticide/PCB-TCL	EPA-CLP	see Table D6	+/- 100%	see Table D6	85%
Total Metals-TAL	EPA-CLP	see Table D6	+/- 100%	see Table D6	85%
Oil and Grease	SW846-9071A/EPA 413.2	+/- 50%	+/- 100%	75-125%	85%
Total Organic Carbon	EPA Lloyd Khan method	+/- 50%	+/- 100%	75-125%	85%
Particle Size Analysis	ASTM D-421/422	NA	NA	NA	85%
Moisture Content	ASTM D-2216	NA	NA	NA	85%
Hydrometer (Finer than 200 Sieve)	ASTM D-1140	NA	NA	NA	85%
CU W/PP (b)	ASTM-D4767	NA	NA	NA	85%
Soil Classification	ASTM D-2487	NA	NA	NA	85%
Atterberg Limits	ASTM D-4318	NA	NA	NA	85%
pH	LaMotte	NA	NA	NA	85%

**NOTES:**

NA = Not applicable

TCL = CLP Target Compound List, see CLP Statement of Work OLM03.2

TAL = CLP Target Analyte List, see CLP Statement of Work ILM04.0.

ASTM = American Society for Testing and Materials, Volume 04.08, 1990.

Precision expressed as either percent relative standard deviation (%RSD) or relative percent difference (%RPD).

Accuracy expressed as percent recovery of matrix spike or laboratory control sample.

Precision and accuracy for CLP parameters provided in Table D6.

Representativeness and Comparability are non-quantitative parameters.

Field and laboratory precision based upon Region II validation guidelines.

(a) While the goal for completeness of laboratory measurements is 90%, the goal for total completeness (sampling and analytical) is 85%.

(b) Consolidated undrained triaxial compression with pore water pressure measurement.

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TABLE D6

**LABORATORY ACCURACY AND PRECISION\* CRITERIA  
FOR NON-AQUEOUS CLP SAMPLES**

<b>VOLATILE ORGANICS:</b>		<b><u>QC LIMITS</u></b>
<b><u>Target Compound</u></b>	<b><u>% Recovery</u></b>	<b><u>% RPD</u></b>
1,1-Dichloroethene	59%-172%	0%-22%
Trichloroethene	62%-137%	0%-24%
Benzene	66%-142%	0%-21%
Toluene	59%-139%	0%-21%
Chlorobenzene	60%-133%	0%-21%
<b><u>Surrogate Compound</u></b>		
Toluene-d8	81%-117%	Not Applicable
Bromofluorobenzene	74%-121%	Not Applicable
1,2-Dichloroethane-d4	70%-121%	Not Applicable
<b>SEMIVOLATILE ORGANICS:</b>		<b><u>QC LIMITS</u></b>
<b><u>Target Compound</u></b>	<b><u>% Recovery</u></b>	<b><u>% RPD</u></b>
Phenol	26%-90%	0%-35%
2-Chlorophenol	25%-102%	0%-50%
1,4-Dichlorobenzene	28%-104%	0%-27%
N-Nitroso-di-n-propylamine	41%-126%	0%-38%
1,2,4-Trichlorobenzene	38%-107%	0%-23%
4-Chloro-3-methylphenol	26%-103%	0%-33%
Acenaphthene	31%-137%	0%-19%
4-Nitrophenol	11%-114%	0%-50%
2,4-Dinitrotoluene	28%-89%	0%-47%
Pentachlorophenol	17%-109%	0%-47%
Pyrene	35%-142%	0%-36%
<b><u>Surrogate Compound</u></b>		
Nitrobenzene-d5	23%-120%	Not Applicable
2-Fluorobiphenyl	30%-115%	Not Applicable
Terphenyl-d14	18%-137%	Not Applicable
Phenol-d5	24%-113%	Not Applicable
2-Fluorophenol	25%-121%	Not Applicable
2,4,6-Tribromophenol	19%-122%	Not Applicable

TABLE D6

**LABORATORY ACCURACY AND PRECISION\* CRITERIA  
FOR NON-AQUEOUS CLP SAMPLES**

<b>PESTICIDES:</b>		<b><u>QC LIMITS</u></b>	
<b><u>Target Compound</u></b>	<b><u>% Recovery</u></b>		<b><u>% RPD</u></b>
gamma-BHC (Lindane)	46%-127%		0%-50%
Heptachlor	35%-130%		0%-31%
Aldrin	34%-132%		0%-43%
Dieldrin	31%-134%		0%-38%
Endrin	42%-139%		0%-45%
4,4'-DDT	23%-134%		0%-50%
<b><u>Surrogate Compound</u></b>			
Tetrachloro-m-xylene	30%-150%		Not Applicable
Decachlorobiphenyl	30%-150%		Not Applicable
<b>INORGANICS:</b>		<b><u>QC LIMITS</u></b>	
<b><u>Target Analyte</u></b>	<b><u>% Recovery</u></b>		<b><u>% RPD</u></b>
Metals	75%-125%		0%-100% (a)

**NOTES:**

- \* - Accuracy and Precision Criteria based upon CLP methods and CompuChem QA/QC studies as well as Region II data validation guidelines.
- (a) - Maximum % RPD is 100% if concentration is greater than five times the Contract Required Detection Limit (CRDL). If the concentration is less than five times the CRDL, the precision limit is +/-2 times the CRDL.

TABLE D7

**ANALYTICAL METHODS, SAMPLE CONTAINERS, PRESERVATION AND  
ANALYTICAL HOLD TIMES FOR AQUEOUS SAMPLES**

PARAMETER	METHODOLOGY	CONTAINER	MINIMUM SAMPLE	PRESERVATION (d)	FIELD FILTERED	HOLD TIME (e)
Volatile Organics-TCL	CLP OLM03.2	3-40 ml G	3 - 40 ml	Cool 4 deg C; HCl, pH<2	No	14 days (a)
Semi-Volatile Organics-TCL	CLP OLM03.2	2-1000 ml Amber G	1000 ml	Cool 4 deg C	No	7 days (b)
Total Metals - TAL	CLP ILM04.0	1-500 ml P	250 ml	Cool 4 deg C; HNO <sub>3</sub> , pH<2	No	180 days (c)
Pesticide/PCB-TCL	CLP OLM03.2	2-1000 ml Amber G	1000 ml	Cool 4 deg C	No	7 days (b)
Oil and Grease	SW846-9070/EPA 413.2	1-1000 ml G	500 ml	Cool 4 deg C; H <sub>2</sub> SO <sub>4</sub> , pH <2	No	28 days
Total Organic Carbon	SW846 9060	1-1000 ml G	500 ml	Cool 4 deg C; H <sub>2</sub> SO <sub>4</sub> or HCL, p	No	28 days

**NOTES:**

- (a) The hold time will be 7 days for unpreserved sample.  
 (b) 7 days for extraction, 40 days for analysis after commencement date of extraction.  
 (c) Hold time for Mercury is 28 days.  
 (d) Sample Preservation is performed by sampler immediately upon sample collection.  
 (e) Hold time based upon day of sample collection not verified time of sample receipt.

1. CLP SOW OLM03.2 is the Statement of Work for Organic Analysis.  
 2. CLP SOW ILM04.0 is the Statement of Work for Inorganic Analysis.

TCL = CLP Target Compound List

TAL = CLP Target Analyte List

P = Polyethylene

G = Glass

Golder Associates

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TABLE D8

ANALYTICAL METHODS, SAMPLE CONTAINERS, PRESERVATION AND  
ANALYTICAL HOLD TIMES FOR NON-AQUEOUS SAMPLES

PARAMETER	METHODOLOGY	CONTAINER	MINIMUM SAMPLE	PRESERVATION	HOLD TIME (c)
Volatile Organics-TCL	EPA-CLP	1-4 oz G	30 gm	Cool 4 deg C	10 days
Semi-Volatile Organics-TCL	EPA-CLP	1-8 oz Amber G	30 gm	Cool 4 deg C	7 days (a)
Pesticide/PCB-TCL	EPA-CLP	1-8 oz Amber G	30 gm	Cool 4 deg C	7 days (a)
Total Metals-TAL	EPA-CLP	1-8 oz P or G	50 gm	Cool 4 deg C	180 days (b)
Oil and Grease	SW846-9071A/EPA 413.	1-4 oz P or G	4 oz	Cool 4 deg C	28 days
Total Organic Carbon	EPA Lloyd Khan method	1-4 oz P or G	4 oz	Cool 4 deg C	28 days
Particle Size Analysis	ASTM D-421/422	SS/ST	1.5 kg	None	NA
Moisture Content	ASTM D-2216	SS/ST	5000 gm	None	NA
Hydrometer (Finer than 200 Sieve	ASTM D-1140	SS/ST	1 kg	None	NA
CU W/PP (f)	ASTM D-4767	ST	(d)	(e)	NA
Soil Classification	ASTM D-2487	SS/ST	NA	None	NA
Atterberg Limits	ASTM D-4318	SS/ST	500 gm	None	NA
pH	LaMotte	SS/ST	500 gm	None	NA

**NOTES:**

All samples will be prevented from freezing.

(a) 7 days for extraction, 40 days for analysis after commencement date of extraction.

(b) Hold time for Mercury is 28 days.

(c) Hold time based upon day of sample collection not verified time of sample receipt.

(d) Shelby tube samples only - Need a minimum of 30 inches recovery per tube if at all possible.

(e) Wax-sealed ends with caps; store in a vertical position.

(f) Consolidated undrained triaxial compression with pore water pressure measurement.

1. CLP SOW OLM03.2 is the Statement of Work for Organic Analysis.

2. CLP SOW ILM04.0 is the Statement of Work for Inorganic Analysis.

3. ASTM = American Society for Testing and Materials, Volumes 04.08 and 04.09, 1995.

NA = Not Applicable

P = Polyethylene

TCL = CLP Target Compound List

G = Glass

TAL = CLP Target Analyte List

SS = Split Spoon

ST = Shelby Tube

**Attachment D1**

CompuChem's Standard Laboratory Quality Assurance Plan  
has been intentionally omitted from this copy  
(CompuChem's QAP was submitted with the Final Work Plan  
Amendment, December 1995)

**Attachment D2**





STATE OF NEW JERSEY  
DEPARTMENT OF  
ENVIRONMENTAL PROTECTION AND ENERGY



*Certifies That*

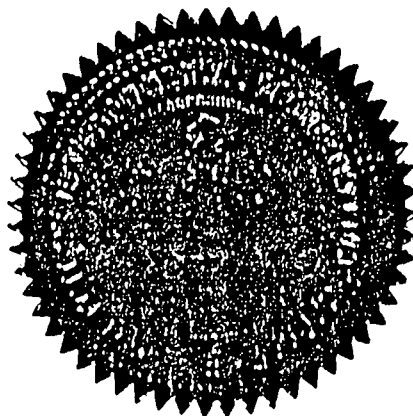
CompuChem Environmental Corporation  
3306 Chapel Hill/Nelson Highway  
Research Triangle Park, North Carolina 27709-4998

*having duly met the requirements of the  
Regulations Governing Laboratory Certification  
And Standards Of Performance N.J.A.C. 7:18 et. seq.  
is hereby approved as a*

**State Certified Environmental Laboratory**

*To perform the analyses as indicated on the Annual Certified Parameter List  
which must accompany this certificate to be valid*

# 67249  
PERMANENT CERTIFICATION NUMBER  
January 18, 1994  
DATE



*Jeanne M. Fox*  
COMMISSIONER, DEPARTMENT OF  
ENVIRONMENTAL PROTECTION AND ENERGY

This certification is subject to unannounced laboratory inspections as specified by  
N.J.A.C. 7:18-2.11(d) and agreed to by the Laboratory Manager on filing the application

TO BE CONSPICUOUSLY DISPLAYED AT THE LABORATORY WITH THE ANNUAL CERTIFIED PARAMETER LIST.

STATE OF NEW JERSEY  
DEPARTMENT OF ENVIRONMENTAL PROTECTION  
OFFICE OF QUALITY ASSURANCE  
ANNUAL CERTIFIED PARAMETER LIST FOR 1994-1995

HEM ENVIRONMENTAL CORP. (67249) IS CERTIFIED TO PERFORM THE ANALYSES  
BELOW UNTIL JUNE 30 1995.

ATER POLLUTION LABORATORY CERTIFICATION

LIMITED CHEMISTRY

00556 OIL AND GREASE  
00615 NITRITE  
00630 NITRATE  
00680 ORGANIC CARBON, TOTAL  
00720 CYANIDE, TOTAL  
00722 CYANIDE, AMEN TO CHLOR  
00940 CHLORIDE  
00945 SULFATE  
Q0951 FLUORIDE, TOTAL  
01032 CR HEX  
32730 PHENDLS

METALS

00915 CALCIUM (ICAP)  
00925 MAGNESIUM (ICAP)  
00929 SODIUM (ICAP)  
01000 ARSENIC (ICAP)

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LAB 67249  
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TER POLLUTION LABORATORY CERTIFICATION

METALS

01002 ARSENIC (AA/GF)  
01025 CADMIUM (ICAP)  
01030 CHROMIUM (ICAP)  
01035 COBALT (ICAP)  
01040 COPPER (ICAP)  
01045 IRON (ICAP)  
01049 LEAD (ICAP)  
01051 LEAD (AA/GF)  
01059 THALLIUM (AA/GF)  
01060 MOLYBDENUM (ICAP)  
01065 NICKEL (ICAP)  
01075 SILVER (ICAP)  
01085 VANADIUM (ICAP)  
01090 ZINC (ICAP)  
01105 ALUMINUM (ICAP)  
01145 SELENIUM (ICAP)  
01147 SELENIUM (AA/GF)  
71900 MERCURY (COLD VAPOR)

ORGANICS

608 PESTICIDES & PCBS (GC)  
624 PURGEABLES (GC/MS)

ATER POLLUTION LABORATORY CERTIFICATION

ORGANICS

625 B/N, ACIDS & PEST (GC/MS)

99007 PESTICIDES

39330 ALDRIN

39380 DIELDRIN

39360 DDD

39365 DDE

39370DDT

39410 HEPTACHLOR

39350 CHLORDANE

IS LIST MUST BE CONSPICUOUSLY DISPLAYED WITH THE PERMANENT  
RTIFICATE AT THE LABORATORY

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LAB 67249  
10/11/94

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**Attachment D3**

GOLDER ASSOCIATES INC.  
GEOTECHNICAL LABORATORY  
QUALITY ASSURANCE PROGRAM PLAN

Laboratory Manager:

Robert J. Wilson 06/29/95  
Signature Date

Laboratory QA Manager:

Mark D. Loselle 06/29/95  
Signature Date

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GOLDER ASSOCIATES INC.  
LABORATORY QUALITY ASSURANCE PROGRAM PLAN

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## 1.0 LABORATORY QUALITY ASSURANCE POLICY AND PROGRAM OBJECTIVES

### 1.1 Statement of Policy

The methods and procedures selected for the Mt. Laurel, New Jersey Geotechnical Laboratory is expressed within this Laboratory Quality Assurance Program Plan (LQAPP). This LQAPP is consistent with the overall requirements of Golder Associates Inc. (Golder Associates) Corporate Quality Policy and the baseline Quality Assurance Program Plan (QAPP) for the Mt. Laurel office.

### 1.2 Objective

The primary objective of this plan is to establish a framework of management procedures that will ensure that the laboratory analyses conducted by the Mt. Laurel Geotechnical Laboratory are performed correctly, are properly documented, and are fully defensible in terms of compliance with standard engineering and scientific practices.

### 1.3 Definitions

#### 1.3.1 Calibration

Calibration is the periodic comparison of an instrument or measurement device to a standard of known and greater accuracy in order to ensure the continuity, precision, and accuracy of the measurement or data. Calibration should not be construed as those instrument adjustments or operational checks commonly performed as part of regular use. The term calibration applies specifically to systematic, periodic evaluations of instrumentation or equipment that verify performance within specified levels of accuracy, precision and repeatability.

#### 1.3.2 Quality

Quality in laboratory activities is defined as compliance with Golder Associates management requirements as defined by this plan.

Such requirements are invoked to ensure the technical competence of the tests, the satisfaction of the client or end user of laboratory data and results, and the fitness for use of all deliverable reports or recommendations.



### **1.3.3 Quality Assurance**

As applicable to laboratory activities, Quality Assurance (QA) refers to the documentation of all planned and systematic actions necessary to provide adequate confidence that all laboratory activities will satisfy given requirements for quality.

### **1.3.4 Quality Assurance Program**

As applicable to laboratory activities, the QA program contains those selected management controls, methods, programs, plans, or procedures that collectively ensure that the quality needs and requirements of Golder Associates, its clients, and the organization responsible for accreditation, are satisfied on all contracts.

### **1.3.5 Quality Control**

As applicable to laboratory activities, the term Quality Control refers to specific operational techniques and activities that are used to fulfill requirements for quality. These techniques include the routine application of procedures in order to obtain prescribed standards of performance.

### **1.3.6 Surveillance Inspection**

Surveillance inspection is a management tool that may be used in the course of laboratory activity to verify that work in progress is being performed in compliance with this LQAPP and applicable technical procedures. Surveillance inspection is used to identify potential deficiencies on a real time basis prior to project completion in order to minimize adverse affects on laboratory quality.

## **1.4 Document Control**

This document and its appendices are considered controlled; review, approval, distribution, and revision should be controlled under the direction of the Mt. Laurel office manager. Recipients of this plan and its subsequent revisions and updates are responsible for maintaining all documents in compliance with the specific requests of documentation memoranda.

## **2.0 ORGANIZATION**

### **2.1 Management Structure**

Figure 1 outlines the laboratory organization of the Mt. Laurel Office.

### **2.2 Responsibilities**

#### **2.2.1 Principal or Associate-In-Charge**

A Principal or Associate of Golder Associates will be responsible for overseeing the laboratory, authorizing the purchase of equipment, preparing short and long-range goals, and ensuring personnel qualifications.

#### **2.2.2 Laboratory Manager**

The Laboratory Manager has the responsibility for the implementation of the Laboratory Quality Assurance Program Plan and general laboratory maintenance. Responsibilities of the Laboratory Manager include ensuring that the following tasks are properly carried out; training, technical direction to laboratory staff, calibration and maintenance of the measuring and test equipment, monitoring of all field equipment, document control of test records, and the review of analytical results, and preparation and/or review of final client reports, as requested.

#### **2.2.3 Quality Assurance Manager**

The Quality Assurance Manager is responsible for monitoring the effectiveness of the LQAPP through regularly scheduled audits and surveillance. The Quality Assurance Manager or his/her designated representative is also responsible for the preparation and maintenance of this plan and its supporting procedures.

### **3.0 TRAINING AND QUALIFICATIONS OF LABORATORY PERSONNEL**

All laboratory personnel shall be trained in the specific requirements of this plan and the procedures governing analytical work. The technical qualifications of laboratory personnel to perform their assigned tasks will be based on a combination of verification of individual academic and professional qualifications when the employee is first hired, as well as training sessions, reading assignments, and periodic performance evaluations. Training records and personnel qualification records will be maintained in laboratory files, and in personnel records as appropriate.

#### **4.0 LABORATORY PROCEDURE**

All laboratory tests shall be initiated by a project-specific Schedule of Laboratory Tests form. The form is to be prepared by the Project Engineer or Project Manager and reviewed by the Laboratory Manager or a suitably qualified technician before any testing is started.

The scope of the required tests, personnel work assignments, and specific procedures to be followed shall be noted in the "comments" section of the form or by the Project Engineer or Project Manager. The form facilitates an actively updated graphic representation of test completion status. Completed forms and all appended memoranda shall be retained as project records; while the original shall be routed to project files, and a copy retained in a reference file in the laboratory.

#### **4.2 Test Procedures**

Laboratory activities shall be controlled through the use of appropriate methods and procedures. Analytical work will be performed in compliance with the accredited procedures listed in the Laboratory Operations Plan. Other technical and QA procedures shall be drawn upon to support the laboratory program or meet unique client needs.

Other technical procedures may be used if specifically required by clients or by project-specific QA program or project plans.

#### **4.3 Sample Identification and Location Control**

Procedures for sample identification are set out in the Laboratory Operational Plan and this should be consulted for details.

#### **4.4 Laboratory Records**

All original laboratory records shall be routed to individual project files when completed, and consequently are subject to the records management controls required by the Quality Assurance Policy Program Plan for the Mt. Laurel office. Copies shall be retained for reference in the laboratory.

#### **4.5 Maintenance and Calibration**

All Golder Associates-owned or leased measuring equipment and test equipment used in performance of laboratory analyses shall be subject to a calibration and maintenance program. Calibration and maintenance status tracking will be provided through use of an approved equipment calibration/maintenance recall system which meets the requirements of the procedure.

Calibration program requirements do not apply to standard commercial measurement devices such as rulers, tape measures, compasses, mercury thermometers, or levels, provided that standard equipment provides the required level of accuracy.

## **5.0 VERIFICATION OF DATA AND REVIEW OF REPORTS**

Test computations shall be performed by assigned Laboratory Technicians under the direction of the Laboratory Manager. All analytical data and calculations shall be reviewed and checked prior to submittal to the client in compliance with the requirements of the Mt. Laurel office baseline Quality Assurance Program Plan.

All analytical reports, data, or routine written client communications shall be performed as set out by the Laboratory Operations Plan.

## **6.0 SURVEILLANCE AND AUDITING**

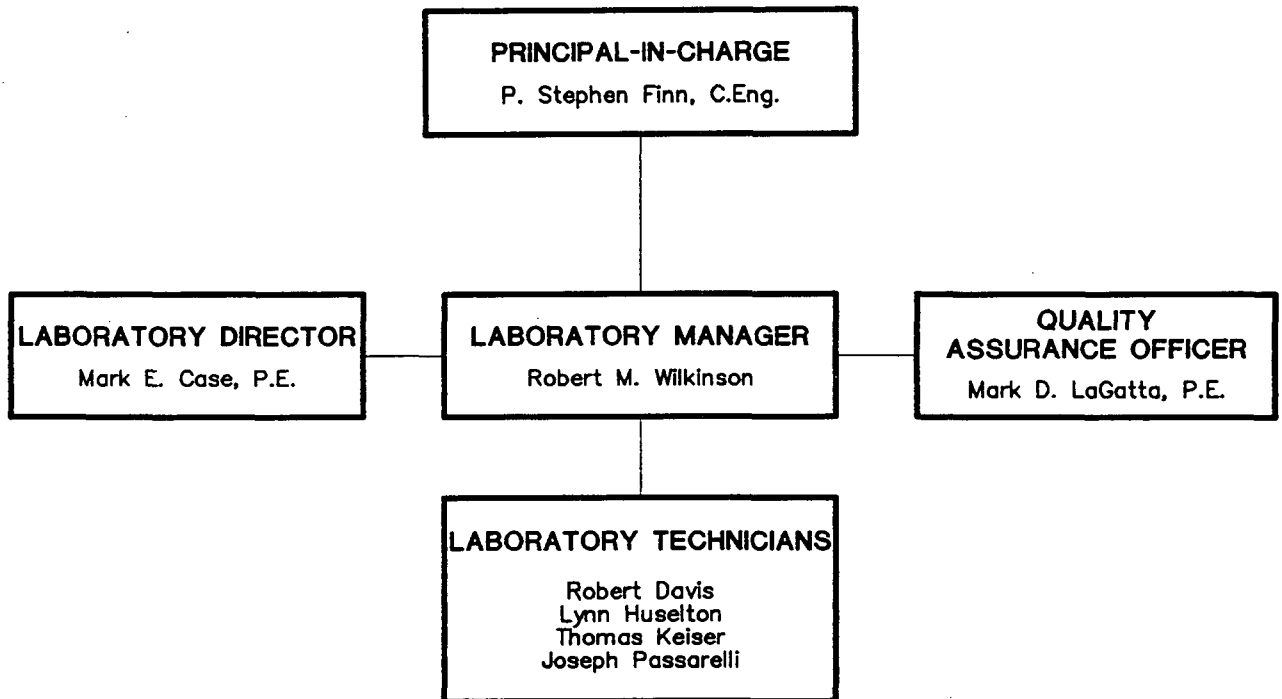
### **6.1 Surveillance Inspection**

Surveillance inspections will be performed at least annually for representative analytical activities. Surveillance will be performed to evaluate conformance to the governing procedures. Surveillance schedules will be coordinated with the Laboratory Manager. Surveillance will be formally documented. Any observed nonconformance will be documented, resolved, and corrective action measures instituted.

### **6.2 Quality Auditing**

Comprehensive internal audits will be performed on at least an annual basis to determine compliance of laboratory operations with the requirements of this plan and as set out in the Laboratory Operations Plan.

D:\PROJECTS\943-6222\FS-WP\QAPP\LABQAPP.DOC



APP 6 3 1996

JOB No.: 943-6222	SCALE: N/A	<b>LABORATORY MANAGEMENT STRUCTURE</b>
DR BY: MRM	DATE: 04/03/96	
CHK BY: <i>Sam</i>	FILE No.: NJ03-451	
REV BY: <i>PSL</i>	DR SUBTITLE: 09	
<b>Golder Associates</b>		216 PATERSON PLANK ROAD SITE
		FIGURE <b>1</b>



**Attachment D4**

101191

1.0 VOLATILES TARGET COMPOUND LIST AND CONTRACT REQUIRED QUANTITATION LIMITS

Volatiles	CAS Number	Quantitation Limits			
		Water	Lcw Soil	Med. Soil	On Column
		ug/L	ug/Kg	ug/Kg	(ng)
1. Chloromethane	74-87-3	10	10	1200	(50)
2. Bromomethane	74-83-9	10	10	1200	(50)
3. Vinyl Chloride	75-01-4	10	10	1200	(50)
4. Chloroethane	75-00-3	10	10	1200	(50)
5. Methylene Chloride	75-09-2	10	10	1200	(50)
6. Acetone	67-64-1	10	10	1200	(50)
7. Carbon Disulfide	75-15-0	10	10	1200	(50)
8. 1,1-Dichloroethene	75-35-4	10	10	1200	(50)
9. 1,1-Dichloroethane	75-34-3	10	10	1200	(50)
10. 1,2-Dichloroethene (total)	540-59-0	10	10	1200	(50)
11. Chloroform	67-66-3	10	10	1200	(50)
12. 1,2-Dichloroethane	107-06-2	10	10	1200	(50)
13. 2-Butanone	78-93-3	10	10	1200	(50)
14. 1,1,1-Trichloroethane	71-55-6	10	10	1200	(50)
15. Carbon Tetrachloride	56-23-5	10	10	1200	(50)
16. Bromodichloromethane	75-27-4	10	10	1200	(50)
17. 1,2-Dichloropropane	78-87-5	10	10	1200	(50)
18. cis-1,3-Dichloropropene	10061-01-5	10	10	1200	(50)
19. Trichloroethene	79-01-6	10	10	1200	(50)
20. Dibromochloromethane	124-48-1	10	10	1200	(50)
21. 1,1,2-Trichloroethane	79-00-5	10	10	1200	(50)
22. Benzene	71-43-2	10	10	1200	(50)
23. trans-1,3-Dichloropropene	10061-02-6	10	10	1200	(50)
24. Bromoform	75-25-2	10	10	1200	(50)
25. 4-Methyl-2-pentanone	108-10-1	10	10	1200	(50)
26. 2-Hexanone	591-78-6	10	10	1200	(50)
27. Tetrachloroethene	127-18-4	10	10	1200	(50)
28. 1,1,2,2-Tetrachloroethane	79-34-5	10	10	1200	(50)
29. Toluene	108-88-3	10	10	1200	(50)
30. Chlorobenzene	108-90-7	10	10	1200	(50)
31. Ethylbenzene	100-41-4	10	10	1200	(50)
32. Styrene	100-42-5	10	10	1200	(50)
33. Xylenes (total)	1330-20-7	10	10	1200	(50)

2.0 SEMIVOLATILES TARGET COMPOUND LIST AND CONTRACT REQUIRED QUANTITATION LIMITS

Semivolatiles	CAS Number	Quantitation Limits			
		Water	Low	Med.	On
			Soil	Soil	Column
		ug/L	ug/Kg	ug/Kg	(ng)
34. Phenol	108-95-2	10	330	10000	(20)
35. bis-(2-Chloroethyl) ether	111-44-4	10	330	10000	(20)
36. 2-Chlorophenol	95-57-8	10	330	10000	(20)
37. 1,3-Dichlorobenzene	541-73-1	10	330	10000	(20)
38. 1,4-Dichlorobenzene	106-46-7	10	330	10000	(20)
39. 1,2-Dichlorobenzene	95-50-1	10	330	10000	(20)
40. 2-Methylphenol	95-48-7	10	330	10000	(20)
41. 2,2'-oxybis (1-Chloropropane) <sup>1</sup>	108-60-1	10	330	10000	(20)
42. 4-Methylphenol	106-44-5	10	330	10000	(20)
43. N-Nitroso-di-n-propylamine	621-64-7	10	330	10000	(20)
44. Hexachloroethane	67-72-1	10	330	10000	(20)
45. Nitrobenzene	98-95-3	10	330	10000	(20)
46. Isophorone	78-59-1	10	330	10000	(20)
47. 2-Nitrophenol	88-75-5	10	330	10000	(20)
48. 2,4-Dimethylphenol	105-67-9	10	330	10000	(20)
49. bis(2-Chloroethoxy) methane	111-91-1	10	330	10000	(20)
50. 2,4-Dichlorophenol	120-83-2	10	330	10000	(20)
51. 1,2,4-Trichlorobenzene	120-82-1	10	330	10000	(20)
52. Naphthalene	91-20-3	10	330	10000	(20)
53. 4-Chloroaniline	106-47-8	10	330	10000	(20)
54. Hexachlorobutadiene	87-68-3	10	330	10000	(20)
55. 4-Chloro-3-methylphenol	59-50-7	10	330	10000	(20)
56. 2-Methylnaphthalene	91-57-6	10	330	10000	(20)
57. Hexachlorocyclopentadiene	77-47-4	10	330	10000	(20)
58. 2,4,6-Trichlorophenol	88-06-2	10	330	10000	(20)
59. 2,4,5-Trichlorophenol	95-95-4	25	830	25000	(50)
60. 2-Chloronaphthalene	91-58-7	10	330	10000	(20)
61. 2-Nitroaniline	88-74-4	25	830	25000	(50)

<sup>1</sup>Previously known by the name bis(2-Chloroisopropyl) ether.

Exhibit C -- Section 2  
Semivolatiles (SVOA)

Semivolatiles	CAS Number	Quantitation Limits			
		Water ug/L	Low Soil ug/Kg	Med. Soil ug/Kg	On Column (ng)
62. Dimethylphthalate	131-11-3	10	330	10000	(20)
63. Acenaphthylene	208-96-8	10	330	10000	(20)
64. 2,6-Dinitrotoluene	606-20-2	10	330	10000	(20)
65. 3-Nitroaniline	99-09-2	25	830	25000	(50)
66. Acenaphthene	83-32-9	10	330	10000	(20)
67. 2,4-Dinitrophenol	51-28-5	25	830	25000	(50)
68. 4-Nitrophenol	100-02-7	25	830	25000	(50)
69. Dibenzofuran	132-64-9	10	330	10000	(20)
70. 2,4-Dinitrotoluene	121-14-2	10	330	10000	(20)
71. Diethylphthalate	84-66-2	10	330	10000	(20)
72. 4-Chlorophenyl- phenyl ether	7005-72-3	10	330	10000	(20)
73. Fluorene	86-73-7	10	330	10000	(20)
74. 4-Nitroaniline	100-01-6	25	830	25000	(50)
75. 4,6-Dinitro-2- methylphenol	534-52-1	25	830	25000	(50)
76. N-Nitroso- diphenylamine	86-30-6	10	330	10000	(20)
77. 4-Bromophenyl- phenylether	101-55-3	10	330	10000	(20)
78. Hexachlorobenzene	118-74-1	10	330	10000	(20)
79. Pentachlorophenol	87-86-5	25	830	25000	(50)
80. Phenanthrene	85-01-8	10	330	10000	(20)
81. Anthracene	120-12-7	10	330	10000	(20)
82. Carbazole	86-74-8	10	330	10000	(20)
83. Di-n-butylphthalate	84-74-2	10	330	10000	(20)
84. Fluoranthene	206-44-0	10	330	10000	(20)
85. Pyrene	129-00-0	10	330	10000	(20)
86. Butylbenzylphthalate	85-68-7	10	330	10000	(20)
87. 3,3'- Dichlorobenzidine	91-94-1	10	330	10000	(20)
88. Benzo(a)anthracene	56-55-3	10	330	10000	(20)
89. Chrysene	218-01-9	10	330	10000	(20)
90. bis(2-Ethylhexyl) phthalate	117-81-7	10	330	10000	(20)
91. Di-n-octylphthalate	117-84-0	10	330	10000	(20)
92. Benzo(b)fluoranthene	205-99-2	10	330	10000	(20)
93. Benzo(k)fluoranthene	207-08-9	10	330	10000	(20)

Exhibit C -- Section 2  
Semivolatiles (SVOA)

Semivolatiles	CAS Number	Quantitation Limits			
		Water	Low Soil	Med. Soil	On Column
		ug/L	ug/Kg	ug/Kg	(ng)
94. Benzo(a)pyrene	50-32-8	10	330	10000	(20)
95. Indeno(1,2,3-cd)- pyrene	193-39-5	10	330	10000	(20)
96. Dibenzo(a,h)- anthracene	53-70-3	10	330	10000	(20)
97. Benzo(g,h,i)perylene	191-24-2	10	330	10000	(20)

3.0 PESTICIDES/AROCLORS TARGET COMPOUND LIST AND CONTRACT REQUIRED  
QUANTITATION LIMITS<sup>2,3</sup>

Pesticides/Aroclors	CAS Number	Quantitation Limits		
		Water ug/L	Soil ug/Kg	On Column (pg)
98. alpha-BHC	319-84-6	0.050	1.7	5
99. beta-BHC	319-85-7	0.050	1.7	5
100. delta-BHC	319-86-8	0.050	1.7	5
101. gamma-BHC (Lindane)	58-89-9	0.050	1.7	5
102. Heptachlor	76-44-8	0.050	1.7	5
103. Aldrin	309-00-2	0.050	1.7	5
104. Heptachlor epoxide <sup>4</sup>	111024-57-3	0.050	1.7	5
105. Endosulfan I	959-98-8	0.050	1.7	5
106. Dieldrin	60-57-1	0.10	3.3	10
107. 4,4'-DDE	72-55-9	0.10	3.3	10
108. Endrin	72-20-8	0.10	3.3	10
109. Endosulfan II	33213-65-9	0.10	3.3	10
110. 4,4'-DDD	72-54-8	0.10	3.3	10
111. Endosulfan sulfate	1031-07-8	0.10	3.3	10
112. 4,4'-DDT	50-29-3	0.10	3.3	10
113. Methoxychlor	72-43-5	0.50	17	50
114. Endrin ketone	53494-70-5	0.10	3.3	10
115. Endrin aldehyde	7421-93-4	0.10	3.3	10
116. alpha-Chlordane	5103-71-9	0.050	1.7	5
117. gamma-Chlordane	5103-74-2	0.050	1.7	5
118. Toxaphene	8001-35-2	5.0	170	500
119. Aroclor-1016	12674-11-2	1.0	33	100
120. Aroclor-1221	11104-28-2	2.0	67	200
121. Aroclor-1232	11141-16-5	1.0	33	100
122. Aroclor-1242	53469-21-9	1.0	33	100
123. Aroclor-1248	12672-29-6	1.0	33	100
124. Aroclor-1254	11097-69-1	1.0	33	100
125. Aroclor-1260	11096-82-5	1.0	33	100

<sup>2</sup>There is no differentiation between the preparation of low and medium soil samples in this method for the analysis of pesticides/Aroclors.

<sup>3</sup>The lower reporting limit for pesticide instrument blanks shall be one-half the CRQL values for water samples.

<sup>4</sup>Only the exo-epoxy isomer (isomer B) of heptachlor epoxide is reported on the data reporting forms (Exhibit B).

# INORGANIC TARGET ANALYTE LIST (TAL)

Analyte	Contract Required Detection Limit <sup>(1,2)</sup> (ug/L)
Aluminum	200
Antimony	60
Arsenic	10
Barium	200
Beryllium	5
Cadmium	5
Calcium	5000
Chromium	10
Cobalt	50
Copper	25
Iron	100
Lead	3
Magnesium	5000
Manganese	15
Mercury	0.2
Nickel	40
Potassium	5000
Selenium	5
Silver	10
Sodium	5000
Thallium	10
Vanadium	50
Zinc	20
Cyanide	10

- (1) Subject to the restrictions specified in the first page of Part G, Section IV of Exhibit D (Alternate Methods - Catastrophic Failure) any analytical method specified in SOW Exhibit D may be utilized as long as the documented instrument or method detection limits meet the Contract Required Detection Limit (CRDL) requirements. Higher detection limits may only be used in the following circumstance:

If the sample concentration exceeds five times the detection limit of the instrument or method in use, the value may be reported even though the instrument or method detection limit may not equal the Contract Required Detection Limit. This is illustrated in the example below:

For lead:

Method in use - ICP

Instrument Detection Limit (IDL) - 40

Sample concentration - 220

Contract Required Detection Limit (CRDL) - 3